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divisions names in subfamily form (Phallostethinae and Neostethinae). Berg (1940: 465–466) recognized these groups as families, naming them Phallostethidae and Neostethidae. I see no particular advantage (or disadvantage) in this revised arrangement.

Berg elevated the Phallostethoidea to ordinal rank, calling the group Phallostethiformes. Departing from the judgment of other recent workers and reverting part way to Regan's view, Berg separated this group widely from the Mugiliformes (to use his ordinal nomenclature), and located it immediately after the Cyprinodontiformes. In line with this action he stated:

> . . . It is obvious that the Phallostethiformes constitute a distinct order related to the Cyprinodontiformes but manifesting a further step towards the Perciformes (Acanthopterygii).

Whether or not a suborder or an order be recognized for the Phallostethidae, on the basis of the bizarre copulatory organ (the priapium) and of other structures, is, like most questions of ranking, of no great inherent significance. Whether the relationship of the family is with Cyprinodontidae or with the Atherinidae, or with neither, is a problem of greater meaning.

Comparison of the Fin Structure of the Phallostethidae with That of the Percesoces

The fin structure of the Phallostethidae (best illustrated in Herre's 1925 figures) confirms the opinion now usually held that this family is referable to the Acanthopterygii, and is not inconsistent with the view that the phallostethids are members of the Percesoces. The lack of a spine at the front of the second dorsal, however, suggests that the Phallostethidae are to be excluded from a position within or immediately derivative from the Atherinidae.

The first dorsal fin of the Phallostethidae, when developed, resembles that of all Percesoces in being much smaller than the second dorsal and widely separated from that fin. As in most Atherinidae the dorsal spines are slender and flexible.[1] The first dorsal begins behind the anal origin, as it does in a few atherinids.

This agreement in the character of the first dorsal fin does not provide conclusive evidence of relationship, for other, not closely related acanthopterygian fishes, such as most Gobioidei, have a small, usually separate first dorsal fin composed of a few flexible spines. The evidence becomes much more impressive, when it is considered in connection with the structure of the other fins. Most of these supplementary characters have remained undescribed or have been erroneously interpreted.

As in most Percesoces (and certain other groups) the second dorsal fin is rather small, pointed at the upper anterior end and inserted posteriorly,

1 The first dorsal fin of the Atherinidae is composed of slender, flexible spines, except in most of the Melanotaeniinae. In most genera of that subfamily the first spine of both of the dorsal fins and of the anal fin, and in one genus all of the spines in these three fins, are thick and pungent (Jordan and Hubbs, 1919: 12–14, 21–29). Weber and de Beaufort (1922: 266–311, figs. 70–83) described and figured the flexible dorsal spines of Melanotaeniinae as unbranched soft rays. The spines of the first dorsal in the Atherinidae number 0 to 9. The fin is rarely obsolete in the atherinopsine species *Basilichthys semotilus* (see Jordan and Hubbs, 1919: 87; Eigenmann, 1922: 188–190), and is lacking in *Notocheirus hubbsi* Clark (1937: 87–90, 1 fig.), another South American member of the Atherinopsinae.

well behind the anal origin. The origin of the second dorsal fin is farther back than in any other percesocines except a few atherinids. This fin lacks the spine which characterizes all Atherinidae and also all Polynemidae, another family referred to the Percesoces (the spine of the second dorsal fin in all but a few of the Atherinidae is a short, slender, flexible structure, similar to the anal spine; that of the Polynemidae, is a robust, pungent spine). This feature, however, does not exclude the Phallostethidae from the Percesoces, because in the Mugilidae the first ray of the second dorsal is also a soft ray, with definite articulations evident at least in the flexible tip. The first ray of the second dorsal in the Sphyraenidae is probably also to be interpreted as a modified soft ray, despite the fact that it is unsegmented, because it is a bilaterally paired structure consisting of two hard rods separated by a band of connective tissue. The first ray of the second dorsal in the Phallostethidae differs from the corresponding ray in the Mugilidae in being less consolidated basally and from that of the Sphyraenidae in the retention of the articulations. This ray is small in those families, but in the Phallostethidae it is not reduced in size, for it reaches to the pointed tip of the fin. The first full-length ray of the second dorsal of all Percesoces other than the Phallostethidae is the second rather than the first ray (in the Atherinidae and Sphyraenidae this ray is unbranched, like the first ray of the phallostethids; in the Mugilidae and Polynemidae it is branched). There are characters in the second dorsal fin, therefore, that separate the Phallostethidae from all other families of the Percesoces (saying "other families," on the assumption that the phallostethids are referable to that group). Furthermore, there are characters in this fin that distinguish all of the families from one another.

I find no evidence to support the statement, made only by Herre (1942: 137), that the second dorsal fin of the Phallostethidae contains one or two spines. The first two rays in all specimens examined are very clearly articulated.

In the structure of the anal fin the Phallostethidae agree with the Atherinidae [2] and differ from all other percesocine families. The first anal ray is a short, flexible spine, forming a solid (not paired) structure, without trace of segmentation, and with the opalescent appearance in transmitted light that is characteristic of spine as contrasted with soft ray constitution. The basal embedded portion of this spine serves as the attachment of longitudinal muscle fibers, and in this region the spine in at least one species (*Plectrostethus palawanensis*) is somewhat swollen. The second anal ray is an unbranched soft ray, quite like the first ray of the second dorsal fin. It is strongly articulated and reaches to the pointed tip of the fin. All of the other rays of this moderately elongate fin are branched as well as segmented. The anal soft rays are approximately twice to thrice as numerous as are the rays of the second dorsal fin.

The anal fin structure in the other families of Percesoces is different

2 An Australian fresh-water genus, *Nannatherina*, with 3 anal spines, was retained in the Atherinidae as the type of a new subfamily by Jordan and Hubbs (1919: 19), but has recently been regarded by Regan (1940) as not belonging to this family.

from that of the Phallostethidae and Atherinidae. In the Mugilidae it is the fourth rather than the second ray which reaches the pointed tip of the fin. This ray is the first one that is branched, whereas in the phallostethids and atherinids the third ray, the second one of full length, is the first that is forked. Instead of having only one thin flexible anal spine all mugilids have 2 thick pungent anal spines, and the third ray with age transforms (in the Mugilinae but not in the Agonostominae) from a flexible, paired, articulated soft ray into a pungent, solid, unsegmented spine (Jacot, 1920: 207–208). In the Sphyraenidae the first full-length ray is unbranched, as in the Phallostethidae and Atherinidae, but this is the third rather than the second ray, and the two short preceding rays are more or less completely paired bilaterally instead of being solid like the single spine of the phallostethids and atherinids. The polynemids have 3 stiff anal spines.[3]

The forked caudal fin is one of the many features in which the Phallostethidae agree with the Percesoces in general.[4] Again this character by itself would be insignificant, but when considered in connection with other characters, takes on meaning. As in the Percesoces and most other typical, free-swimming fishes, the principal caudal rays of the Phallostethidae are all branched, except for the two that form the upper and lower margins, respectively. The number of principal rays in all specimens examined is fewer than 17, which is the usual and basic number of the Percomorphi, including the Atherinidae and other Percesoces (Regan, 1913: 111; Jordan and Hubbs, 1919: 8). This number is never exceeded in the percomorphs, except by very rare individual variation, but is often lowered in species with reduced caudal fins, and in dwarfed fishes like the Phallostethidae. Reductions in numbers of parts frequently accompany dwarfing in fishes, as noted by Te Winkel (1935, 1939).

The more or less elevated and pointed pectoral fin, with an oblique base and with a single, uppermost, full-length, unbranched ray, is another feature which links the Phallostethidae with the Percesoces, but which, taken alone, could not be held to be of critical significance

The lack of pelvics in the Phallostethidae removes one fin character that might have furnished evidence on the relationship of the family. Several students of the group, particularly Bailey (1936) and Aurich (1937), assumed that pelvic elements are involved in the formation of the elaborate priapium, and Aurich (1937) and Te Winkel (1939: 59–61) described and figured rudimentary pelvics in immature male specimens of certain species.

I conclude that the entire fin structure of the Phallostethidae confirms the indications, derived from other common features in appearance and in external and internal anatomy, that this family is referable to the Percomorphi and probably to the percomorph division, Percesoces. In one feature, the lack of the spine at the front of the second dorsal fin, the Phallostethidae differ notably from the Atherinidae. In other respects the

[3] In some species of Polynemidae the first spine is an embedded tubercle, which has been overlooked in systematic descriptions. Weber and de Beaufort (1922: 197–200) indicated that there are only 1 or 2 anal spines in *Eleutheronema,* but in 2 Chinese specimens of *E. tetradactylum* I find 3 developed anal spines.

[4] Except for a few fresh-water atherinids of Madagascar, all Percesoces have a forked caudal.

fin structure of the phallostethids differs from that of each of the other families of Percesoces. Each family has distinctive fin characters. There is nothing in the fin structure, however, that would necessarily exclude the phallostethids from the Mugiloidea (the percesocine division which includes the Atherinidae, Mugilidae and Sphyraenidae). The recognition within the Percesoces of a group, Phallostethoidea, coordinate with the Mugiloidea and Polynemoidea, must rest on other characters, particularly the marvelously elaborate copulatory structure known as the priapium.

Critical Remarks on Fin Structure of Phallostethidae

That the fin structure of the Phallostethidae is consistently of the type detailed in the preceding comparisons is indicated by the scrutiny of numerous specimens of each of three genera, representing both subfamilies—or families if you wish. The material is that preserved in the United States National Museum (just examined by courtesy of Dr. Leonard P. Schultz, Curator of Fishes) and in the Museum of Zoology of the University of Michigan. The species which have been studied are *Phenacostethus smithi* Myers (1928), *Neostethus amaricola* (Villadolid and Manicop, 1934), and *Plectrostethus palawanensis* Myers (1935). All of the many specimens examined of these species, representing three very distinct genera and the two larger groups, have the true spines confined to: (1) the one or two rays of the first dorsal; and (2) the single spine always developed at the front of the anal fin.

The distinction of spines and soft rays is not difficult in the phallostethids, but in these small fishes requires strong illumination by transmitted light and high magnification, preferably to be secured with a compound microscope. The soft rays, whether simple or branched, are seen to be composed of a pair of rods lying side to side, each made up of a row of rectangular articulations (modified scales). The spines are observed to be solid and median (unpaired) structures, without trace of articulation and with an internal structure, as indicated by the refraction of the transmitted light, quite different from that of the soft rays. Under these conditions the spines have a clarity and an opalescence that is easier to recognize than to describe. These are the typical, fundamental distinctions between spines and soft rays.

The various authorities on the Phallostethidae, other than Herre, have overlooked the single anal spine and have not stated definitely that the first ray of the second dorsal fin is an unbranched soft ray. Berg (1940: 465) categorically wrote that the fins other than the first dorsal are spineless. Herre alone has indicated that spines are developed at the front of the second dorsal and anal fins. The formulas given in the original descriptions of *Gulaphallus eximius* and *G. mirabilis* (Herre, 1925) indicated two spines in the first dorsal, one in the second dorsal and one in the anal. The figures, however, nicely illustrate the presumably true formula: two spines in the first dorsal, no spine but instead one unbranched soft ray in the second dorsal, and one spine plus one unbranched soft ray in the anal. *Mirophallus bikolanus* Herre (1926: 540) was described as having "Dorsal 1–6; and 1–14,"

but the figure shows one unbranched ray without articulations at the front margin of the second dorsal (the lack of articulations was almost surely the artist's error), and one spine in the anal followed by an articulated ray which is drawn (erroneously, I assume) as branched. In his outstanding contributions of 1939 and 1942 Herre indicated by description and by text statement that there are one or two spines at the front of the second dorsal and of the anal fin, usually one in the second dorsal and two in the anal. For *Neostethus amaricola* he ascribed either one or two spines to each fin, but in large series of this species in the National Museum I fail to find a single spine in the second dorsal fin of any specimen, and see one spine and one only at the front of the anal fin in all examples. In every specimen with unbroken rays it is seen that the first soft ray of each fin, and only this one soft ray, is unbranched.

Herre also indicated by the assigned formula (as I, 8), but not by text statement, that the pectoral fin likewise bears a spine at its front (upper) edge. In all pectoral fins of the phallostethids which I have examined the first ray is an articulated soft ray, differing from the following rays in being unbranched.

It is clear that Herre confused unbranched rays with spines. Such confusion has been rather general, and needs to be rigidly avoided if we are to take full advantage of fin structure in taxonomic interpretations.

Contrast between Phallostethidae and Cyprinodontes in Fin Structure

Every fin furnishes contrasts when the Phallostethidae and the Cyprinodontes are compared in detail. The ensemble of characters thoroughly justifies the general view that there is no close relationship between these groups.

The Cyprinodontes (the Microcyprini of Regan, 1911) totally lack true spines in any of the fins. They show no trace of a first dorsal fin, and the first anal ray is obviously a soft ray—well developed in the Cyprinodontidae, almost rudimentary in the Poeciliidae. In certain of the Cyprinodontidae the first ray of the dorsal fin is expanded laterally and is rather strongly ossified, and its bony portion has a pointed tip surmounted by a deciduous soft filament (Hubbs, 1936: 219, 223), but this ray is obviously only a modified soft ray, not a true spine. The first ray of the second dorsal, unlike that of the Phallostethidae, does not reach the tip of the fin. In most cyprinodonts the first soft ray of the anal fin is likewise not a full-length ray.

The caudal fin of the Cyprinodontes is typically rounded rather than forked (Hubbs, 1942: 399), and, as detailed elsewhere (Hubbs, 1936: 212), may comprise more than the 17 principal rays that form the basic number of the Percesoces and other Percomorphi—a number subject to decrease but not to increase (Regan, 1913*a*: 111; Jordan and Hubbs, 1919: 8).

The pectoral fin in many if not most cyprinodonts has a small ray above (in front of) the main, upper, unbranched ray, but no such short ray appears in the Phallostethidae. The pelvic fin of the Cyprinodontes provides a contrast with the Percesoces (but of course not with the Phallostethidae).

It lacks the spine which is developed in all percesocines having a pelvic fin, and the soft rays instead of being consistently 5 vary from 0 to 9, with 6 as the most frequent number.

It now seems quite clear that the points of special resemblance between the Cyprinodontes and the Atherinidae, which once impressed me forcibly and which Myers (1928: 3–4) considered with a degree of favor, may be ascribed plausibly to convergent evolution. The Cyprinodontes may well have been derived from some group standing near the base of the Acanthopterygii, but they can hardly be regarded as very close relatives of any of the Percesoces.

It is certainly true that the superficial resemblance between the Phallostethidae and the Horaichthyidae is due to convergence. Despite many similarities these Asiatic families differ too strikingly in the structure both of the general body parts and of the complex clasping organs, to be regarded as relatives (Kulkarni, 1940; Hubbs, 1941). There is no reason to doubt the validity of the assignment to the Cyprinodontes of *Horaichthys*—a fish even more remarkably specialized than any of the Phallostethidae.

General Remarks on Comparative Studies of Fin Structure

The high value of fin structure in the classification of fishes is clearly evident in the foregoing comparisons of the Phallostethidae with each of the recognized families of the Percesoces. Numerous differences distinguish the phallostethids from each of the percesocine families. Furthermore each of those families has its own peculiarities of fin structure. Some of the distinguishing characters are fundamental when considered in terms of basic anatomy. Others might be regarded as relatively trivial, but derive their value in these family comparisons from the factor of consistency—which, after all, is the best test of the significance of a character.

Endless errors and inconsistencies have marked the efforts of ichthyologists to utilize fin structure in the classification of fishes. For example, as I have recently pointed out (Hubbs, 1943), most authors have failed to appreciate that in the gobioid fishes (Eleotridae, Gobiidae, etc.) the first ray of the second dorsal fin and of the anal fin is a true though flexible spine (in that review I should have observed that Herre, 1927, etc., long anticipated Schultz, 1943: 221–255, in the use of correct formulas for the fin rays of the Gobioidei). The descriptions and formulas of almost all workers have indicated that the first ray of the second dorsal in the Mugilidae is a spine, but close inspection of many species shows the tip to be consistently articulated, proving this rod to be a soft ray. Formulas and descriptions, for instance those of Jordan and Evermann (1896: 822–826) and Weber and de Beaufort (1922: 218–229), indicate that the number of spines at the front of the second dorsal and anal fins of the Sphyraenidae varies from 1 to 2 or even 3, but I find no essential variation among several species of the western Atlantic, California, Hawaii, Japan and the Philippines. Furthermore the anterior rays of reduced size (always 1 in the second dorsal and 2 in the anal fin) are, as noted above, bilaterally paired and hence probably modified soft rays rather than spines.

Much of such inconsistent and erroneous treatment of fin structure has arisen from cursory examination. It is only recently that systematic ichthyology has outgrown the hand lens and jeweler's eye-piece era. I do not say this disparagingly, for a prodigous amount of basic work was accomplished with the crude tools of the generation of workers from whom many of us received our training. Unfortunately, some workers still fail to take advantage of modern research equipment, which makes greater precision possible.

It is vital, whenever possible, that we distinguish rays as either soft rays or true spines, on the basis of fundamental differences in structure (p. 73). It is clear from the foregoing comparisons that it is often valuable to carry the distinction farther. This is particularly true of the simple and branched soft rays, which form many different and distinctive patterns in different groups. Still further analysis is often advantageous. Thus, as I show above, the first ray of the second dorsal fin in both the Mugilidae and in the Sphyraenidae may be regarded as a soft ray, but this ray in the Mugilidae retains articulations but has fused halves, whereas that of the Sphyraenidae retains its bilaterally double structure but has lost the articulations. If one has only a single sample of this ray from a member of each family, he will be able to identify the family with ease. Relative length, thickness, boniness, pointedness and many other differentiae, of both soft rays and spines, often provide diagnostic characters.

It is obvious, therefore, that simple formulas, though still of value, cannot adequately portray all features of fin structure: descriptions are also needed. It is desirable, of course, that ichthyologists follow uniform symbols in stating fin formulas (the usage I prefer has recently been stated by Hubbs and Lagler, 1941: 13–16). For instance the conventional representation of spines by Roman and of soft rays by Arabic figures should be maintained. No matter how small, thin or flexible they may be, true spines should be indicated in the formulas by Roman numerals. When the true situation is described or thoroughly understood, however, no particular harm will result from following custom in the enumeration of heavily ossified soft rays, like the "spines" of siluroids, by Roman figures.

Some authors have enumerated unbranched soft rays in small capital Roman numerals, but have been so inconsistent in the usage that doubts often arise over what is meant. Other authors have used lower case Roman figures for unbranched soft rays. Thus Schultz (1944), in a treatise just published on Venezuela catfishes, consistently enumerates both the simple and the branched rays, in such formulas as iii, 15. His specifications of rays to be represented by lower case Roman numerals (*"Simple, flexible, non-pungent rays"*) would include flexible spines, but he assures me that this was not his intent. Schultz finds that the number of soft rays that are unbranched often provides characters of systematic value among the siluroids, and he tells me that this is true also of the characins, on which he will soon publish.

When it is desirable to specify the number of both unbranched and branched rays, the system adopted by Schultz is probably to be preferred. The query naturally comes to mind, Should we consistently make this distinction in writing the formulas for fin-ray numbers? Several arguments

against the obligatory separation of unbranched and branched soft rays come to mind: (1) such usage for certain species, for instance a flatfish with 88 (lxxxviii) simple rays in the dorsal fin, would be very cumbersome; (2) in some groups the rays show only a slight trace of terminal branching, too difficult to detect for purposes of enumeration; (3) in some fishes the rays are simple in the young and become branched so belatedly and so irregularly that the distinction of the two types is impracticable or misleading; (4) in fishes like most American cyprinids the anteriormost simple ray is a minute structure often requiring careful dissection to find, the number of "rudimentary" rays is not significant, and the number of principal rays (or of branched rays, equaling principal rays minus 1) is the critical and adequate character; (5) in still other fishes, the number of simple rays is invariable throughout the family (3 in the anal fin of the Poeciliidae, for example). In treating fishes of the last category it is a waste of space and effort to separate the simple and branched rays in the enumerations. The number of branched rays, or of principal rays, or of total rays is adequate. For the Poeciliidae I use total rays, to be consistent in the order Cyprinodontes. I conclude that in some groups the numbers of branched and unbranched rays should be separately specified in the formulas, but that this should not be made a universal or required practice.

In a recent letter Schultz offers the suggestion that pungent spines be indicated by upper case Roman numerals; flexible spines, by lower case Roman figures.

The important point is to make certain what is the true structure of the rays, and then by formula, definition or description to make it clearly understood how the rays are enumerated. And, to conclude, the simple formulas often need to be supplemented by descriptions, for there are more types of spines and of simple and branched soft rays than any workable formulas can indicate.

Summary

Diverse views have been held regarding the relationships of the Phallostethidae, a remarkable family of small fishes of southeastern Asia. The discovery that some species have a spinous dorsal led to a shift in classification from the Cyprinodontes to the Percesoces. The import of other features in the fin structure has not been appraised.

The separated first dorsal fin of the Phallostethidae contains 0 to 2 spines. The posteriorly inserted second dorsal comprises one unbranched soft ray reaching to the tip of the fin and a moderate number of branched rays. The first anal ray is invariably a small spine; the second ray is an unbranched soft ray similar to the first ray of the second dorsal; the remaining anal rays, twice to thrice as numerous as the rays of the second dorsal, are all branched. The forked caudal fin has fewer than 17 principal rays. The pointed pectoral is inserted rather high and has one ray unbranched (the pelvics are lacking).

This fin structure confirms the classification of the Phallostethidae in the Acanthopterygii and is consistent with their allocation in the Percesoces, but provides characters that separate this family from each of the other per-

cesocine families, including the Atherinidae. In fact all families of Percesoces are consistently distinguishable by fin characters. The fin structure of the Phallostethidae is incompatible with the location of this family within or near the Cyprinodontes. The similarities between the Cyprinodontes and the Atherinidae seem to be due to convergence.

Endless errors and inconsistencies have marked the descriptions of fins and fin formulas. Very commonly spines and unbranched soft rays have been confused. The distinction of simple and branched soft rays is often of critical significance, and further differentiation of types is frequently of value. Fin formulas are needed but can not adequately portray all fin characters. Accurate descriptions based on thorough comparative studies are also called for. Precision and consistency are particularly needed in the interpretation of the fin characters, and are obtainable with modern laboratory equipment. Fin structure, when accurately determined and thoroughly studied, provides many characters of high value in taxonomic and phylogenetic research.

Literature Cited

Aurich, H.

1937 Die Phallostethiden (Unterordnung *Phallostethoidea* Myers). [Mitteilungen XIX der Wallacea-Expedition Woltereck 1931–32]. *Intern. Rev. ges. Hydrob. und Hydrogr.*, 34: 263–286, figs. 1–11.

Bailey, Ralph Jordan

1936 The osteology and relationships of the phallostethid fishes. *Jour. Morph.*, 59: 453–483, pls. 1–4, fig. 1.

Berg, Leo S.

1940 Classification of fishes, both Recent and fossil. *Trav. Inst. Zool. Acad. Sci. URSS*, 5: 87–517, figs. 1–190.

Clark, H. Walton

1937 New fishes from the Templeton Crocker Expedition in 1934–35. Copeia, 1937 (2): 88–91, 2 figs.

Eigenmann, C. H.

1922 The fishes of western South America, Part I. The fresh-water fishes of northwestern South America, including Colombia, Panama, and the Pacific slopes of Ecuador and Peru, together with an appendix upon the fishes of the Rio Meta in Colombia. *Mem. Carn. Mus.*, 9; 1–346, pls. 1–38, figs. 1–21.

Herre, Albert W. C. T.

1925 Two strange new fishes from Luzon. *Phil. Jour. Sci.*, 27: 507–513, pls. 1–2.

1926 Four new Philippine fishes. *Ibid.*, 31: 533–543, pls. 1–3.

1927 Gobies of the Philippines and the China Seas. *Monogr. Bur. Sci., Manila, P. I.*, 23: 1–352, frontisp., pls. 1–30.

1939 The genera of Phallostethidae. *Proc. Biol. Soc. Wash.*, 52: 139–144.

1942 New and little known phallostethids, with keys to the genera and Philippine species. *Stanford Ichth. Bull.*, 2: 137–156, fig. 1.

Hubbs, Carl L.

1924 Studies of the fishes of the order Cyprinodontes. I. A classification of the fishes of the order. *Misc. Publ. Mus. Zool., Univ. Mich.*, 13: 3–4.

1936 Fishes of the Yucatan Peninsula. *Carn. Inst. Wash. Publ.* 457: 157–287, pls. 1–15, fig. 1.

1941 A new family of fishes [A review of Kulkarni, 1940]. *Jour. Bombay Nat. Hist. Soc.*, 42: 446–447.

1942 An atherinid fish from the Pliocene of Oklahoma. *Journ. Paleont.*, 16: 399–400.

1943 [Review of] Fishes of the Phoenix and Samoan islands collected in 1939 during the expedition of the U. S. S. "Bushnell." By Leonard P. Schultz. Copeia, 1943 (2): 133–134.

HUBBS, CARL L., and KARL F. LAGLER
1941 Guide to the fishes of the Great Lakes and tributary waters. *Bull. Cranbrook Inst. Sci.*, 18: 1–100, figs. 1–118.

JACOT, ARTHUR PAUL
1920 Age, growth and scale characters of the mullets, *Mugil cephalus* and *Mugil curema*. *Tran. Am. Microsc. Soc.*, 39: 199–229, pls. 20–26, figs. 1–7.

JORDAN, DAVID STARR
1923 A classification of fishes including families and genera as far as known. *Stanford Univ. Publ.*, (*Univ. Ser.*) *Biol. Sci.*, 3: 77–243, i-x.

JORDAN, DAVID STARR, and BARTON WARREN EVERMANN
1896 The fishes of North and Middle America: a descriptive catalogue of the species of fish-like vertebrates found in the waters of North America, north of the Isthmus of Panama. *Bull. U. S. Nat. Mus.*, 47 (pt. 1): 1–lx, 1–1206.

JORDAN, DAVID STARR, and CARL L. HUBBS
1919 Studies in ichthyology. A monographic review of the family of Atherinidae or silversides. *Leland Stanford Jr. Univ. Publ.* (*Univ. Ser.*): 1–87, pls. 1–12.

KULKARNI, C. V.
1940 On the systematic position, structural modifications, bionomics and development of a remarkable new family of cyprinodont fishes from the Province of Bombay. *Rec. Indian Mus.*, 42: 379–423, figs. 1–20.

MYERS, GEORGE S.
1928 The systematic position of the phallostethid fishes, with diagnosis of a new genus from Siam. *Am. Mus. Nov.*, 295: 1–12, figs. 1–2.
1935 A new phallostethid fish from Palawan. *Proc. Biol. Soc. Wash.*, 48: 5–6.
1937 Notes on phallostethid fishes. *Proc. U. S. Nat. Mus.*, 84: 137–143.

REGAN, C. TATE
1911 The osteology and classification of the teleostean fishes of the order Microcyprini. *Ann. and Mag. Nat. Hist.*, (8) 7: 320–327, pl. 8.
1913*a* The classification of the percoid fishes. *Ibid.*, (8) 12: 111–145.
1913*b* Phallostethus dunckeri, a remarkable new cyprinodont fish from Johore. *Ibid.*: 548–555, figs. 1–4.
1916 The morphology of the cyprinodont fishes of the subfamily Phallostethinae, with descriptions of a new genus and two new species. *Proc. Zool. Soc. London*, 1916: 1–26, pls. 1–4, figs. 1–15.
1940 The perciform genera *Gymnapogon* and *Nannatherina*. COPEIA, 1940 (3): 173–175; *Ann. and Mag. Nat. Hist.*, (11) 6: 527–530.

SCHULTZ, LEONARD P.
1943 Fishes of the Phoenix and Samoan islands collected in 1939 during the expedition of the U. S. S. "Bushnell." *Bull. U. S. Nat. Mus.*, 180: i-x, 1–316, figs. 1–27.
1944 The catfishes of Venezuela, with descriptions of thirty-eight new forms. *Proc. U. S. Nat. Mus.*, 94: 173–338, pls. 1–14, figs. 1–5.

TE WINKLE, LOIS E.
1935 A study of Mistichthys luzonensis with special reference to conditions correlated with reduced size. *Jour. Morph.*, 58: 463–535, pls. 1–13.
1939 The internal anatomy of two phallostethid fishes. *Biol. Bull.*, 76: 59–69, figs. 1–3.

VILLADOLID, DEOGRACIAS V., and PORFIRIO R. MANICOP
1934 The Philippine Phallostethidae, a description of a new species, and a report on the biology of Gulaphallus mirabilis Herre. *Phil. Jour. Sci.*, 55: 193–220, pls. 1–5, figs. 1–3.

WEBER, MAX, and L. F. DE BEAUFORT
1922 The fishes of the Indo-Australian Archipelago IV Heteromi, Solenichthyes, Synentognathi, Percesoces, Labyrinthici, Microcyprini. Leiden: E. J. Brill: i–xiii, 1–410, figs. 1–103.

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Return of Two Marked Pink Salmon (*Oncorhynchus gorbuscha*) to the Natal Stream from Distant Places in the Sea

By A. L. Pritchard

IN 1937 Dr. A. G. Huntsman (Science, 85: 313–314) after examining the available data on salmon migration, made the following observation:

> On inquiry and examination of the literature I have failed to find a single clear case of a salmon returning to its natal river from a distant place in the sea, that is, away from the neighborhood of the river mouth. Admittedly this is a difficult thing to prove, since we must be sure of three things for the individual fish: (1) Which is the natal river? (2) where it has been in the sea, and (3) that it is again in its river. Perhaps some one may be able to produce such evidence. Without it, however, it seems pointless to speak of a "homing instinct."

There resulted a veritable barrage of papers purporting to disprove the statement. Neither these nor the symposium on salmon migration which followed later (Publication No. 8, Amer. Assoc. Adv. Science, 1939: 1–106) produced absolute evidence of the type demanded, although they were replete with circumstantial information which seemed to strongly refute the stand taken. Not one case was submitted of a salmon marked before it left its natal stream, captured in the sea, remarked or tagged, and subsequently recovered in the "parent" river.

In 1942, Huntsman reported (Science, 95: 381–382) that one Atlantic salmon (*Salmo salar*) marked during its descent from the northeast Margaree River in Cape Breton as a smolt in 1938, had been taken at Bonavista on the east coast of Newfoundland in 1940, tagged, and recaptured in the "home" stream later in the same season. This individual had apparently been captured in the ocean far from the bulk of the marked fish described as "congregated along a 16-mile stretch of coast, largely north of the river mouth, where is the definite zone of influence of the Margaree River."

During the spring of 1942, a total of 101,194 pink salmon fry (*Oncorhynchus gorbuscha*) were marked by removal of both ventral fins during seaward migration from Morrison Creek, a small tributary of the Puntledge River on the east coast of Vancouver Island, British Columbia. These were but a small proportion of the whole migration from the stream. On August 19, 1943, field assistants of the Pacific Biological Station tagged a marked male pink salmon in Deep Water Bay, Johnstone Strait, about 45 miles north of Morrison Creek. On August 30, Mr. A. C. DeLacy of the Washington State Department of Fisheries tagged another marked male off Lopez Island in Puget Sound, approximately 115 miles south of Morrison Creek. Although all the investigators were fully aware that marked pinks might be discovered in 1943, neither of the marks were recognized as such at the time of tagging. Both salmon, now marked and tagged, reached the counting weir in the "home" stream on October 6.

For Atlantic salmon Huntsman suggested (*op. cit.*, 1937) that the natal river has a zone of influence at sea where the migrations of the species "seem to be definitely controlled by a sufficiently steep gradient in the proportion

of river water, so that the salmon tend to remain where the proportion is high, . . ." It would seem that if a fish happens to get very far from this zone of river influence there is little likelihood that it will in its random wanderings reach the place where the marked gradient occurs. It may then be said to be "lost."

This is apparently not the situation for the two pink salmon in the records just submitted. It is impossible to define the exact direction followed by either of them in their return from the point of tagging to Morrison Creek, but it is certain that only two courses are available. Eventually the route would lead either through the lower part of the Strait of Georgia, or through Johnstone Strait, the narrow connecting passages, viz., Seymour Narrows, Okisollo Channel, or the Yuculta Rapids, and the upper portion of the Strait of Georgia. If the pinks came through the lower part of the Strait of Georgia, they must have crossed at least 20 miles of an area where the Fraser River water is easily recognized (A. H. Hutchinson, Trans. Roy. Soc. Canada, 22, Sec 5, 1928: 293–310). If the northern Johnstone Strait route was followed, they undoubtedly encountered channels where the tidal flow is extremely large, at times even reaching 12 knots on the flood and 10 on the ebb. This heavy current would certainly bring about a complete mixing of the water, obliterate any marked gradient, and preclude the possibility of recognition of the discharge from any special river. In addition Morrison Creek is small and its volume discharge is almost negligible by comparison with the Puntledge and the Courtenay through which its water must flow to reach the sea.

Thus it would appear that at least two fish not only migrated a distance apparently far beyond the zone of influence of the parent stream, but also returned to the tributary even though in so doing, they may have had to pass through the recognized zone of influence of one of the largest rivers on the coast, or through waters where no particular river effect or marked water gradient could be discerned.

An outline of the general behaviour for the Morrison Creek pink salmon, which admittedly involves some circumstantial evidence, may be built up from the two records already discussed and certain other pertinent observations.

The fry left Morrison Creek in the spring of 1942 and reached the sea through the Puntledge and Courtenay rivers. The marked fish returned in large numbers to Morrison Creek, since 865 were recovered at the counting weir. Only one record was obtained from another stream, a doubtful marked female observed in Wolf Creek tributary to the Tsolum River in the Courtenay system. When one considers that slightly over 50,000 dead pink salmon were examined altogether in at least sixteen recognized spawning streams other than Morrison, and that only the doubtful Wolf Creek return was obtained, it would seem reasonable to conclude that, while there is a faint possibility of wandering, almost all returned to the tributary in which they were hatched. At least two of these marked fish, already described, did return from distant places in the sea. That the others may have behaved in the same way is indic .ted by the recovery in Morrison Creek of unmarked

pink salmon tagged in various areas in southern British Columbia during 1943: 41 from Johnstone Strait, 2 from Sooke on the south coast of Vancouver Island and 5 from Puget Sound.

In summary, pink salmon marking and tagging experiments recently conducted in southern British Columbia have shown definitely that at least some of the fish may migrate beyond the zone of influence of their natal stream to a distant place in the sea and return for spawning to that same stream. Other observations and strong circumstantial evidence indicate that this behaviour is general and that the success of return to the parent tributary is exceedingly high.

FISHERIES RESEARCH BOARD OF CANADA, NANAIMO, B. C.

Northward Acclimatization of the Western Mosquitofish, *Gambusia affinis affinis* [1]

By LOUIS A. KRUMHOLZ

THE natural range of the western mosquitofish, *Gambusia affinis affinis* (Baird and Girard), extends from the Gulf Coast of northeastern Mexico, Texas, and Louisiana through the Mississippi River and its tributary waters as far north as the southern parts of Illinois and Indiana. In Illinois this poeciliid is rather common in the waters of the Big Muddy, Little Muddy, Cache, Saline, and lower Little Wabash river drainages and also in the smaller streams tributary to the Mississippi and Ohio rivers in that region. According to Forbes and Richardson (1920), "This little top-minnow, fairly common in extreme southern Illinois, has been taken by us outside that region only from Quincy, Meredosia, and Pekin." That it is indigenous in that region is indicated by the fact that Jordan and Gilbert (1882) described *Zygonectes inurus,* a synonym of *Gambusia affinis affinis,* from the Cache River, Illinois. Luce (1933) reported taking mosquitofish in five collections from the Kalkaskia River between Vandalia and Venedy Station, Illinois. The first report from much further north is that of O'Donnell (1935), who listed *Gambusia affinis* from the Fox River basin in northeastern Illinois in addition to the localities given by Forbes and Richardson. As indicated later it has been determined that this northern record resulted from an introduction. Meek and Hildebrand (1910) did not include this genus in their "Synoptic List of Fishes Known to Occur within Fifty Miles of Chicago," and Thompson and Hunt (1930) did not collect the species from the waters of Champaign County, Illinois, where the Kalkaskia River has its origin. Hubbs and Lagler (1941) did not include the genus in their "Guide to the Fishes of the Great Lakes and Tributary Waters." From this information the parallel of 40° north latitude may be given as the approximate northern limit of the natural range of *Gambusia* in Illinois.

In 1923 some mosquitofish from a small pond on the campus of the

1 Submitted in partial fulfillment of the requirements for the degree of doctor of philosophy in the University of Michigan.

Southern Illinois State Normal University at Carbondale, Illinois, were introduced into a garden pool on the estate of Roland D. Whitman in Winnetka, Illinois. These fish were sent north by J. Lyell Clarke, then Sanitary Engineer at Carbondale. This first planting was augmented by another in 1925. Although these fish did not come from the extreme northern limit of their natural range, it may be assumed that they were much more resistant to cold than they would have been, had they been transferred from a southern state. About Winnetka, more than 300 miles to the north, they were subjected to much more rigorous climatic conditions than those to which they had been accustomed in southern Illinois (Holcomb, 1941: 841–851). Nevertheless, the fish thrived and reproduced with sufficient success to build up a substantial population during the next 10 years.

Mr. J. Lyell Clarke (1939), Sanitary Engineer for the Des Plaines Valley Mosquito Abatement District at Lyons, Illinois, was among the first to suggest the use of fish in mosquito control in the Chicago region. In 1928 ponds on 7 golf courses were stocked with mosquitofish from Carbondale. The fish evidently failed to survive the winter inasmuch as none could be found in the ponds during the summers of 1929 and 1930. It may be that the fish were killed when the ponds were drained periodically to retrieve golf balls which had erred in their flight. In 1933 Clarke drew upon the stock at Whitman's pond in Winnetka for the first time and introduced the fish into 7 ponds in the outlying districts of Chicago in the hope of establishing hatcheries as a source for widespread stocking. The method of dispersal proved satisfactory and as a result more than 100 waters of various types in the vicinity of Chicago have been stocked with "native" mosquitofish since that time. Some of these ponds are quite shallow and require restocking each spring whereas others have maintained their original populations since the first introduction. Since 1938 the writer has been actively interested in the populations of mosquitofish in the ponds near Chicago and is deeply indebted to Mr. Clarke for his assistance, for access to his planting records and for permission to publish some of his data.

As a result of the large scale introductions of *Gambusia* into natural waters, these topminnows are now fairly common throughout Cook County, Illinois. Such plantings are responsible for the mention of mosquitofish from the Fox River basin. Dr. David H. Thompson of the Illinois Natural History Survey has informed me that the fish had been placed in an impoundment of Flynn Creek in the early summer of 1927 and that in August of that year he collected the specimens which O'Donnell recorded in 1935.

Because the original stock of *Gambusia a. affinis* in Whitman's pond was not drawn upon for ten years it is believed that a hardy strain had an opportunity to develop and become well established. Certainly the fish had become acclimatized to the region and were well able to withstand the winters. The degree to which natural selection may have been involved in the acclimatization is an important point to be determined.

In June, 1941, the writer, through the courtesy of the Michigan Institute for Fisheries Research, introduced some of the mosquitofish from the hardy strain at Chicago into several natural waters in southern Michigan. These

fish have successfully passed two winters in the vicinity of Ann Arbor and have thrived and reproduced in large numbers.[2] The winter of 1942-43 was one of the most severe and protracted in the region of Ann Arbor in more than thirty years. Although not the coldest winter, the snowfall was very heavy and the ice cover on the lakes persisted for nearly four months. Under these adverse conditions the topminnows wintered over in 9 natural ponds within a 50-mile radius of Ann Arbor. This is not the first report of *Gambusia* having successfully passed the winter under the ice. Jordan (1927) stated that the director of the Illinois pond at Carbondale (the source of the northern plantings) reported that a foot and a half of ice did not kill any of them as they were all hibernating at the bottom of the pond. The Chicago stock survived the winter of 1935-36 under an ice cover of 26 inches and the winter of 1938-39 under 22 inches of ice. In a pond near Mt. Zion, Illinois (information from Dr. G. W. Bennett of the Illinois Natural History Survey), mosquitofish survived a winter in a pond with a maximum depth of 10 inches including an ice cover of 4 inches. *Gambusia affinis affinis* has also been acclimatized in almost all South European countries and in Germany and Austria, as well as China, Japan, Siam, and other countries (Sokolov, 1936). In the U. S. S. R. this mosquitofish has been widely spread, from Transcaucasus and the Black Sea region through the Ukraine as far north as Moscow. The winters in Russia are certainly as severe as those in Michigan, if not more so, as is evident from the recent war picture in that theater. The stock which was originally sent to Italy and was thence spread to Russia came from the same source (Carbondale, Illinois) that was drawn on for the introductions into the Chicago region (as indicated by correspondence between J. Lyell Clarke and Samuel F. Hildebrand, who was then working for the United States Public Health Service on the use of *Gambusia* for mosquito control). This information provides some basis for the hope that it may be possible to establish mosquitofish in mosquito-infested regions throughout most of the northern United States and even parts of Canada.

In August, 1943, in connection with a research project on malaria control supported by the Horace H. Rackham School of Graduate Studies of the University of Michigan, the writer introduced mosquitofish into 10 ponds and small lakes distributed through the lower peninsula of Michigan from Ann Arbor north to the Straits of Mackinac. If these plantings have withstood the winter of 1943-44 the fish will be introduced into other waters in regions where the mosquitoes are a nuisance or a malaria hazard.

Since 1941, it is known that some of the plantings have escaped from ponds into the Clinton and Huron River systems of southeastern Michigan. No thorough check of these streams has been made to ascertain whether or not the fish have established themselves in the streams.

The value of *Gambusia* in mosquito control was first recognized by Jordan in 1905 when, at the request of the City of Honolulu, Hawaii, he sent Seale (1905) to Texas to get fish of three different genera (***Fundulus grandis, Gambusia affinis,*** and ***Mollienisia latipinna***), in order to ascertain which was

2 Since this paper was written, the writer has found that the mosquitofish has successfully passed a third winter in natural waters in southeastern Michigan.

the best for the control of mosquito larvae. *Gambusia* proved to be more effective than any other fish tested and since that time it has been widely used in malaria control work. Hildebrand (1921), who did considerable antimalaria work during World War I, made the statement, "*Gambusia affinis* is by far the most important natural enemy of the mosquito known to date. . . . The use of *Gambusia affinis* in several southern States during antimalarial campaigns in 1920 resulted in a reduction in the cost of mosquito control and added much to the permanent nature of the work." During the summer of 1943 the writer found the mosquitofish to be about 75 per cent effective in the control of *Anopheles* larvae in natural ponds in Michigan, where no other control measure was used. The studies are being continued.

Literature Cited

Clarke, J. Lyell
1939 Need mosquito control be incompatible with wildlife? *Trans. 4th N. Am. Wildlife Conf.*, 1939: 130–136.

Forbes, Stephen Alfred, and Robert Earl Richardson
1920 The fishes of Illinois. (Second ed.) *Ill. Nat. Hist. Surv.*, 3: i-cxxi, 1–357, figs. 1–76, col. pls. 1–67; Atlas, 103 maps.

Hildebrand, Samuel F.
1921 Top minnows in relation to malaria control, with notes on their habits and distribution. *Pub. Health Bull.* 114: 1–33.

Holcomb, Elward W.
1941 Climate of Illinois. *In:* Climate and Man (*Yearbook of Agriculture, U. S. Dept. Agri.*, 1941).

Hubbs, Carl L., and Karl F. Lagler
1941 Guide to the fishes of the Great Lakes and tributary waters. *Bull. Cranbrook Inst. Sci.*, 18: 1–100, figs. 1–118.

Jordan, D. S.
1927 The mosquito fish (*Gambusia*) and its relation to malaria. *Smithsonian Report*, 1926: 361–368, 4 pls.

Jordan, D. S., and Chas. H. Gilbert
1882 Description of a new cyprinodont (*Zygonectes inurus*) from southern Illinois. *Proc. U. S. Nat. Mus.*, 5: 143–144.

Luce, Wilbur M.
1933 A survey of the fishery of the Kalkaskia River. *Ill. Nat. Hist. Surv.*, 20: 70–123, figs. 1–12.

Meek, S. E., and S. F. Hildebrand
1910 A synoptic list of the fishes known to occur within fifty miles of Chicago. *Publ. Field Mus. Nat. Hist.* (*Zool.*), 7: 223–338, figs. 1–77.

O'Donnell, D. John
1935 Annotated list of the fishes of Illinois. *Bull. Ill. Nat. Hist. Surv.*, 20: 473–500.

Seale, Alvin
1905 Report of Mr. Alvin Seale of the United States Fish Commission, on the introduction of top-minnows to Hawaii from Galveston, Texas. *Hawaiian Forester Agriculturist*, 2: 364–367.

Sokolov, N. P.
1936 L'acclimatisation du *Gambusia patruelis* en Asie centrale. *Rivista Malarialog.*, 1936: 325–344, figs. 1–11.

Thompson, David H., and Francis D. Hunt
1930 The fishes of Champaign County. *Bull. Ill. Nat. Hist. Surv.*, 19: 1–101, figs. 1–6, maps 1–52.

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A Revised List of the Fishes of Barro Colorado, Gatun Lake, Panama

By C. M. Breder, Jr.

A LIST of the fishes known from Barro Colorado was published by the author in 1933. Since then another small collection was made during a short stay of scarcely twenty-four hours (February 11–12, 1934) in company with Mr. Henry Sears. These records together with various faunal notes are herewith presented as a revised list of the Island's fish fauna. In addition to these, Dr. L. C. Turner of Northwestern University has kindly made available his records on a number of species. These are credited to him under the appropriate heads. Nomenclatural changes that have occurred during the interim are indicated, in which the usage of Hildebrand (1938) is followed.

Appreciation is expressed to Mr. James Zetek, Custodian of the Research Station, who made our all too hasty visit pleasant and profitable. The specimens are deposited in the collections of the Bingham Oceanographic Laboratories, Yale University, and were collected during "shore leave" from the second joint expedition of the Bingham Oceanographic Laboratories and the Woods Hole Oceanographic Institution. All measurements refer to standard lengths in mm.

Family Pimelodidae

Rhamdia wagneri (Günther).—One fairly large example was seen but not caught in the second creek on the Shannon trail. Recorded by Breder (1933) and Hildebrand (1938).

Family Characinidae

Compsura gorgonae (Evermann and Goldsborough).—Recorded by Breder (1933) and Hildebrand (1938), only.

Gephyrocharax atricaudata (Meek and Hildebrand).—Known only from three specimens collected in Lutz Creek about 75 yards above its mouth by Dr. Turner.

Astyanax ruberrimus Eigenmann.—Seven specimens of from 41 to 90 mm. were collected in Lutz Creek, near its mouth. None was seen in the other localities visited. Recorded by Breder (1933) and Hildebrand (1938) and collected by Dr. Turner.

Bryconamericus emperador (Eigenmann and Ogle).—Known from the island only from the record of Hildebrand (1938).

Roeboides guatemalensis (Günther).—Several old ones seen near the laboratory dock, Recorded by Breder (1933) and Hildebrand (1938) and collected by Dr. Turner.

Brycon chagrensis (Kner).—Large examples seen near the laboratory dock. Recorded by Breder (1933) and collected by Dr. Turner.

Piabucina panamensis Gill.—Four specimens of from 60 to 128 mm. were collected in Lutz Creek slightly further from its mouth than were the *Astyanax*. One of 118 mm. was taken in the second creek on the Shannon trail. Recorded by Breder (1933) and Hildebrand (1938) and collected by Dr. Turner.

Hoplias microlepis (Günther).—A single example taken near the laboratory dock. Recorded by Hildebrand (1938) and collected by Dr. Turner.

Family Synbranchidae

Synbranchus marmoratus Bloch.—Recorded by Breder (1933) and Hildebrand (1938) and collected by Dr. Turner.

Family Poeciliidae

Gambusia nicaraguensis Günther.—Two examples, 20 and 27 mm., taken at the laboratory dock. Recorded by Breder (1933) and Hildebrand (1938) and collected by Dr. Turner. The former used the name *Gambusia affinis speciosa* Girard, based on the analysis of Hubbs and Gordon MS (still unpublished). Hildebrand (1938), who com-

pared material and investigated the importations of fishes to the Canal Zone, certainly has the weight of evidence on his side and at this writing there appears to be no valid reason for not considering these fishes native *Gambusia*.

Brachyrhaphis episcopi (Steindachner).—Recorded by Hubbs (1926) and Breder (1933) and studied by Turner (1938) in Allee Creek.

B. cascajalensis (Meek and Hildebrand).—Taken at the laboratory dock in Lutz Creek and in the second creek on the Shannon trail. Twenty-four specimens ranging from 21 to 45 mm. Recorded by Hildebrand (1938) and reported by Dr. Turner, personal communication, from Lutz Creek and at the laboratory dock. The latter noted that in an extended series of collections, throughout the year, this and the preceding species, at no time, were found together.

Mollienisia sphenops (Cuvier and Valenciennes).—Recorded by Hildebrand (1938) and collected by Dr. Turner.

FAMILY CYPRINODONTIDAE

Rivulus brunneus Meek and Hildebrand.—Common in the first and second creek on the Shannon Trail. Nineteen specimens of from 23 to 54 mm. In addition to these a number were taken to the old New York Aquarium in a living condition where they accommodated themselves to aquarium life as well as do most species of this genus. Breder (1934) shows a photograph of adult and juvenile living specimens and notes the occurrence of the species on Barro Colorado. Hildebrand (1938) also records it from ". . . pools left in a creek near the end of the dry season. . . ." Breder (1938) expressed the thought that *Rivulus elegans* Steindachner should be expected on the island, because of its occurrence in the Chagres drainage. The specimens from that basin have since been shown to be a different species, *Rivulus montium* Hildebrand. As it is known only from the headwaters and these fishes seem to be rather mutually exclusive in their Panama distributions it is doubtful if the two should be expected on the island.

FAMILY SYNGNATHIDAE

Oostethus lineatus (Kaup).—Three specimens 90, 108 and 135 mm., all males, the two larger with well advanced eggs in their pouches, were taken in the shore weeds at the laboratory dock. Reported by Breder (1933) and Hildebrand (1939) and collected by Dr. Turner. Apparently this species is well established, and successfully breeding at the Island. On a basis of the collections it is likely that this form is abundant. These and other observations, below noted, lead to a consideration of the remarks of Chickering (1930) who suggested a possible passage of this species through the Canal. While such transit remains a possibility it may be pointed out that this species was also collected on this expedition in the Chagres, just below Gatun Spillway and in a small fresh-water stream emptying into Kingston Harbor on the island of Jamaica. Three of the latter, collected January 31, 1934, were brought alive to New York in a one gallon bottle of fresh water, arriving there the middle of March. The living fish is shown in a photograph in Breder (1934). They survived this long journey and became established in a small aquarium. It is thus evident that this species is able to live in fresh water indefinitely and those found in fresh water would not seem to be recent arrivals or temporary transients, even though the Jamaica specimens were taken in a place that almost certainly becomes brackish at times. Consequently it would seem to be at least as likely that those found at Barro Colorado are the descendants of fishes impounded in Gatun Lake on its construction, as that they entered from the sea by way of the locks, as is suggested by Chickering. Furthermore, it may be noted that this species lives amid shore litter and is not apt to occur where water is turbulent, nor is there any reason to suppose it is given to extensive travel. Hildebrand (1939) arrived at a similar conclusion and considers the species as a basically fresh and brackish water form.

FAMILY ATHERINIDAE

Thyrina chagresi (Meek and Hildebrand).—Common about the laboratory dock, but, as noted by E. R. Dunn, in Breder (1933), only evident at night. Nineteen specimens of from 32 to 71 mm. Also collected by Dr. Turner.

FAMILY CICHLIDAE

Aequidens coeruleopunctatus (Kner and Steindachner).—Four examples of from 57

to 100 mm. at the laboratory dock. Recorded by Breder (1933) and Hildebrand (1938) and collected by Dr. Turner.

Cichlasoma maculicauda Regan.—Common about the laboratory dock. Two examples of 81 and 90 mm. collected. Also seen in the various small inlets along the shore to either side of the dock and the lower portion of Lutz Creek. Recorded by Breder (1933) and Hildebrand (1938) and collected by Dr. Turner.

FAMILY CENTROPOMIDAE

Centropomus parallelus Poey.—Recorded by Breder (1933).

FAMILY GOBIIDAE

Gobiomorus dormitor Lacépède.—Four examples of from 57 to 100 mm. collected at the laboratory dock. Recorded by Breder (1933) and Hildebrand (1938) and collected by Dr. Turner.

Leptophilypnus fluviatilis Meek and Hildebrand.—Hildebrand (1938) records three specimens from Gatun Lake seined at Barro Colorado.

This list indicates that seven species have been added to the original Island list: *Gephyocharax atricaudata, Bryconamericus emperador, Hoplias microlepis, Brachyrhaphis cascajalensis, Mollienisia sphenops, Rivulus brunneus* and *Leptophilypnus fluviatilis*. All except *Rivulus brunneus* were indicated as probable by Breder (1933). See discussion under that species. The total number of species now amounts to twenty-two. All except the following are known from the shores of the Island, in Gatun Lake. These eleven species have been taken in the small streams of the island itself: *Rhamdia wagneri, Gephyocharax atricaudata, Astyanax ruberrimus, Piabucina panamensis, Synbranchus marmoratus, Brachyrhaphis episcopi, B. cascajalensis, Rivulus brunneus, Aequidens coeruleopunctatus, Cichlasoma maculicauda,* and *Gobiomorus dormitor*.

Various North American fishes have been introduced into Gatun Lake and also *Lebistes reticulatus* (Peters). According to Hildebrand (1938) the last attempt to introduce foreign fishes was in 1925. The failure of acceptable records of any of the species involved to appear, as is mentioned by Hildebrand (1938), probably, by now, can be taken as an indication of the complete lack of establishment of all of these plantings.

LITERATURE CITED

BREDER, C. M., JR.

1933 The fishes of Barro Colorado, Gatun Lake, Panama. *Zoologica,* 9 (16): 568–572.

1934 The oceanographic vessel *Atlantis* in the West Indies: an account of the second joint expedition sponsored by the Bingham Oceanographic Laboratory and the Woods Hole Oceanographic Institution. *Bull. N. Y. Zool. Soc.,* 37 (2): 31–39.

CHICKERING, A. M.

1930 An Atlantic pipefish caught in transit through the Panama Canal. COPEIA (173): 85–86.

HILDEBRAND, S. F.

1938 A new catalogue of the fresh-water fishes of Panama. *Field Mus. Nat. Hist., Zool. Series* 22 (4): 217–359. Pub. 425.

1939 The Panama Canal as a passageway for fishes, with lists and remarks on the fishes and invertebrates observed. *Zoologica,* 24 (3): 15–45.

HUBBS, C. L.

1926 Studies of the fishes of the order Cyprinodontes. *Misc. Pub. Mus. Zool., Univ. Mich.* (16): 1–87.

TURNER, C. L.
1938 The reproductive cycle of *Brachyrhaphis episcopi*, an ovoviviparous poeciliid fish in the natural tropical habitat. *Biol. Bull.*, 75 (1): 56–65.

NEW YORK ZOOLOGICAL SOCIETY, NEW YORK, NEW YORK.

Notes on the Serranidae and Lobotidae of Texas

By J. L. BAUGHMAN

THE Serranidae is represented in Texas by four known genera and six species; and there is little reason to doubt that further intensive collection will add to this list. These fishes, some of which are part of the commercial catch on the eastern coast, furnish no addition to the fisheries in Texas. None of them attains any great size, and they are considered as trash by fishermen interested only in *Lutianus blackfordi* or *Scomberomorus cavalla*.

Centropristes striatus (Linnaeus): sea bass.—The ordinary range of this fish is from Cape Ann to northern Florida, and although Reed (1941) records it from the Texas coast, it is probably nowhere very plentiful. On the east coast it is found over rocky or coral bottom and about wharves and piling. Food consists of crustaceans, fish, mollusks and plants (Hildebrand and Schroeder, 1928). Adults feed chiefly on crabs and fish, the young on shrimp, isopods and amphipods. Spawning occurs in May on the North Carolina coast, and from the middle of May until late in June off the New Jersey, Long Island, and southern New England coasts. The eggs are buoyant, non-adhesive, and average 1 mm. in diameter. At a temperature of 50° Fahrenheit, they hatch in about five days. Young of the species inhabit the oyster beds (Nichols and Breder, 1927).

Centropristes philadelphicus (Linnaeus): rock sea bass.—Recorded from a location approximately due south of Galveston and due east of Rockport by Weed (1937), little is known of this species. In 1940, however, a number were procured for the Rice Collection at the edge of a coral reef about 15 miles south of Galveston.

Centropristes springeri (Weed): sea bass.—Only three specimens, the type and two paratypes, are known. These came from Pensacola, Florida, and from "Grampus" station No. 10472, due south of Galveston and due east of Rockport, Texas.

Diplectrum formosum (Linnaeus): squirrel fish.—Gunter (1941) records this fish on the authority of Baughman, who states that it is fairly common on the snapper banks. Examples have been taken at Galveston (Heald Bank) and at Freeport, where they are occasionally caught on a hook and line by snapper fishermen. Little is known in regard to the life history. Longley (1932), who had most opportunity to study *Diplectrum*, believed that this species might be functionally hermaphroditic, as are several species of the genus *Prionodes* and *Diplectrum radiale*, a form very closely allied to *formosum*. Although generally caught by snapper fishermen over the reefs, the

normal habitat of this fish appears to be over smooth, sandy or muddy bottoms in rather deep water, and Longley and Hildebrand (1941) state that individuals may have hiding places of their own. "Some they dig by lying down beside stones, vibrating their bodies rapidly, and throwing sand out in clouds; some they find ready made. Once they possess a shelter, day after day they may be seen beside it, darting in when approached by such fishes as the swift carangids." Coloration is extremely variable.

Dules subligarius (Cope): rock fish.—In a recent note by Woods (1942), he lists two specimens (FMNH No. 40264) received from about Corpus Christi, Texas. The specimens (85 and 91 mm. standard length) were identified by Mr. Woods, who found no difference between these and a series from the west coast of Florida.

Hypoplecturus chlorurus (Cuvier and Valenciennes).—Woods (*loc. cit.*) also obtained a single specimen (FMNH No. 40260) of this fish from the Corpus Christi collection. This constitutes a fairly large extension of range for the species.

Lobotes surinamensis (Bloch): triple tail.—Reported from Texas by Baughman (1941), the triple tail is found along the entire coast from Orange to Brownsville. Not common, it varies in its abundance from year to year. Very small specimens have been taken at Galveston, Aransas Pass, Rockport, and about Corpus Christi, while fish with roe have been reported from Freeport, Texas, in May and June.

This fish feeds on spawning crabs (*Callinectes*) at certain seasons of the year.

Literature Cited

Baughman, J. L.
1941 On the occurrence in the Gulf Coast waters of the United States of the triple tail, *Lobotes surinamensis*, with notes on its natural history. *Amer. Nat.*, 75: 569–579.

Gunter, Gordon
1941 Relative numbers of shallow water fishes of the northern Gulf of Mexico, with some records of rare fishes from the Texas Coast. *Amer. Mid. Nat.*, 26 (I): 194–200.

Hildebrand, S. F., and William C. Schroeder
1928 The fishes of Chesapeake Bay. *Bull. U. S. Bur. Fish.*, 43: 1–388, 211 figs.

Longley, W. H.
1932 Observations upon Tortugas fishes. *Ibid.*, 31: 286–287.

Longley, W. H., and S. F. Hildebrand
1941 Systematic catalog of the fishes of Tortugas, Florida. *Pap. Tortugas Lab. Carn. Inst. Wash.*, 34: XII + 331, 34 pls.

Nichols, John T., and Chas. M. Breder, Jr.
1927 The marine fishes of New York and southern New England. *Zoologica*, 9 (I): 1–192, text figs.

Reed, Clyde T.
1941 Marine life in Texas waters. *Tex. Acad. Sci. Publ. Nat. Hist.*, 2: xiv + 88, num. text figs.

Weed, Alfred C.
1937 Notes on sea basses of the genus *Centropristes*. *Pub. Field Mus. Nat. Hist., Zool. Ser.* 20(23): 291–32, 2 figs.

Woods, Loren P.
1942 Rare fishes from the coast of Texas. Copeia, 1942 (3): 191–92.

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The Development of *Eleutherodactylus portoricensis* [1]

By David Gitlin

THE extraordinary development of *Eleutherodactylus portoricensis* Schmidt has been known since 1871, when Bello y Espinosa described a Puerto Rican tree toad, called *coquí* by the natives, that does not undergo metamorphosis and does not have a free larval stage. Peters, in 1876, reported that Gundlach had found some eggs of this species on May 4, 1876. Gundlach, after observing their development, concluded that metamorphosis is absent, that there are no branchiae during development, that the fore and hind limbs appear simultaneously, and that the embryonic period lasts fourteen days from fertilization of the egg to hatching. Unknown to Peters, Bavay (1873) had earlier published several reports on the direct development of a tree toad found in Guadeloupe. Bavay found that on the second day of development, the embryo is observed rotating on a dorso-ventral axis; that on the fourth day branchiae appear; on the fifth day rotation ceases; and on the seventh the branchiae are no longer distinguishable. The embryo hatches on the tenth or eleventh day of development. Both Bavay and Peters described a large membranous tail they believed to be respiratory in function.

Sampson (1904) investigated the embryology of The Jamaican *Eleutherodactylus luteolus* and *nubicola* (reported as "*Hylodes martinicensis*") and concluded that there are no gill slits, no external or internal gills and that there is an early and simultaneous development of the four limbs. She was able to determine the first and second cleavage planes in early development, but her material was inadequate for demonstrating later cleavages. Sampson did not observe living material and consequently used Peters' determination of embryo ages. Peters, Gundlach and Bello had undoubted specimens of *Eleutherodactylus portoricensis;* the name was proposed by Schmidt (1927) after an extensive survey of the confusion of Puerto Rican species with the Lesser Antillean *martinicensis*. It is evident that much remains to be done to establish the specific developmental characteristics of true *martinicensis* and the Jamaican species.

Materials and Methods

The eggs described here were found in groups of bromeliaceae growing along the north bank of a drainage ditch flowing west from Rio Piedras, Puerto Rico. The eggs were available throughout the year, making evident the absence of a definite breeding season. They occur in clusters attached to leaf petioles, a few inches above the level of residual rain water that collects in the axils. The cluster is usually situated on the upper side of the lowest leaf petiole. Several times two clusters were found side by side, appearing as a single egg mass, and once three clusters were found together. The different clusters are easily separated, since the difference in stage of development may be wide.

1 This study was made through the aid of the Naumburg Award of the City College of New York of which the author was the recipient for the year 1941-1942. He is indebted also for the encouragement and supplies so kindly given by Dr. Julio García-Díaz of the University of Puerto Rico and Dr. J. A. Dawson of the City College of New York.

The number of eggs collected totals 675, in 56 clusters. The curve of the number of eggs per cluster versus the frequency of occurrence of that number is bimodal; i.e., 51.8% of the clusters collected have 9, 11, 20, or 21 eggs per cluster and 42.6% have either 9 or 11 eggs per cluster, 9.2% having 20 or 21 eggs. The remainder of the clusters have eggs spreading evenly between 4 and 27 in number. The average is 12 eggs per cluster.

The petioles bearing the eggs were cut off and brought to the laboratory. The eggs were placed in minots containing just enough water to submerge them and kept in the dark at a temperature ranging from 21° to 25.5°C. At designated times, a certain number of eggs were taken off from each cluster and fixed with membranes intact in Bouin's solution or 10% formalin. The eggs were washed in alcohol and brought up to 85% at which stage the membranes were pierced and dissected away. Imbedding was done in steps up to 8% celloidin which was then hardened in chloroform and stored under cedar wood oil. The blocks were infiltrated with paraffin directly from the oil bath. Sections were cut at 10 or 15μ and fixed to the slide with Mayer's albumen. In lieu of absolute alcohol, the slides were passed through carbol—xylol and finally stained in Bullard's hematoxylin and Orange II. The latter stain makes the yolk granules clearly distinguishable and is invaluable for determining the extent of the entoderm.

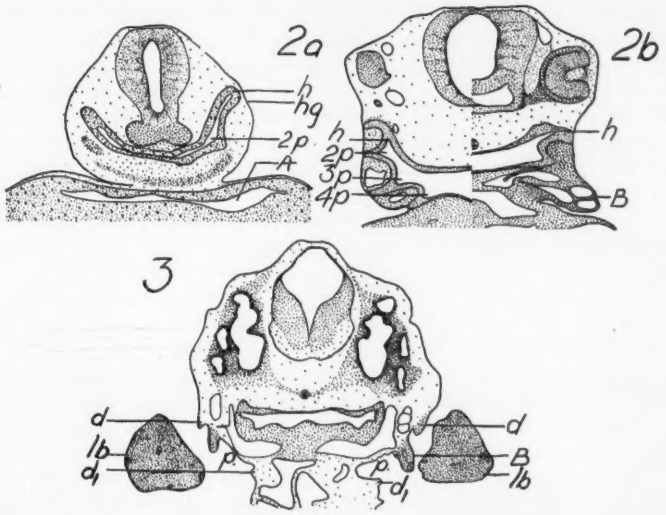
All ages noted in the text are based upon the age of the cluster and not upon the individual embryo, due to the manner in which observations were made. Embryos in the same cluster are often in different stages of development, but the differences are only a matter of thirty minutes or less in the earliest stages. In later stages, however, the differences may be equivalent to several hours. In one instance, the first tree toad in a series hatched two days before the last. Under natural conditions, differences of several hours in the hatching times of the eggs of the same cluster have been noted.

Early Development

In *E. portoricensis*, the first cleavage appears as a small narrow furrow in the animal region, and with development, the furrow widens and extends to the yolk region, externally dividing the egg into halves. A second cleavage plane appears at the animal pole at right angles to the first, but before the second cleavage is completed at the lower pole, the third cleavage planes make their appearance. The third cleavage consists of two furrows at right angles to the first plane of cleavage, one on either side of the second cleavage plane. The second cleavage is soon completed, the third cleavages extend and the egg appears as in Figures 4 and 6. A fourth cleavage occurs at right angles to the first three planes of segmentation, about two-thirds of the way up from the equator as illustrated by Figures 5, 7, and 8. It cuts off twelve cells, eight of which, those of the animal region, show definite division figures; occasionally, instead of eight cells being cut off, only six or seven cells are formed as in Figures 7 and 8. It is possible that a fifth cleavage plane cuts between and parallel to the fourth plane of segmentation and the equator, but this could not be confirmed. Division then becomes complex. The animal cells divide periclinally as well as anticlinally and both at a much more rapid rate than the cells of the yolk laden vegetal region. Very early in development, an irregularly shaped segmentation cavity appears. This later as-

sumes a hemispherical shape in the upper third of the egg. At first, the cavity is bounded at the animal pole by a layer several cells thick. As development proceeds, this layer becomes thinner and the segmentation cavity enlarges. The blastula stage lasts about 14.5 hours after the first appearance of the segmentation cavity. It is to be noted, however, that no division figures or nuclei could be observed in the yolk region of the egg.

At the start of gastrulation, there is an increasing graduation of the size of the cells surrounding the blastocoele from the animal pole to the equator. Around the base of the blastocoele, the cells soon form a rapidly growing and easily distinguished ring, which involutes to start gastrulation. As gastrulation proceeds, the original layer bounding the upper region of the blastocoele becomes but one cell in thickness. Gastrulation is completed in about 11 to 14 hours after the first signs of involution of the germ ring. As in other frogs, a yolk plug is present during these stages.



Figs. 1–3. 1, a transection through a 2 day 17 hours old embryo. 2a, half of an oblique frontal section, oblique with respect to transectional and sagittal planes, cutting through the branchial arches of a 4 days 8 hours old embryo. 2b, half of a section from the same embryo, but ventral and anterior to section 2a. 3, transection through a 7 days embryo. All × 43.

A, archenteron; B, external gills; d, d_1, dermal folds; h, hyomandibular pouch; 1b, anterior limb buds; 2p, second pharyngeal pouch; 3p, third pharyngeal pouch; 4p, fourth pharyngeal pouch.

Gills

The first indications of branchial grooves appear in a 2 days 17 hours embryo, in the cervical region of which are noted two very shallow depressions, the hyomandibular and second branchial grooves. A transsection of the embryo (Fig. 1) shows the formation of the first two pharyngeal pouches. The hyomandibular pouch (h) is quite prominent, but has not yet touched the

ectodermic groove (hg); on the other hand, the second pharyngeal pouch is indefinite and just beginning to form. Two hours later, three shallow branchial grooves, the hyomandibular being the deepest, can be distinguished and in a 2 days 22 hours embryo, four ectodermic grooves are found well-marked as shown in Figures 12 and 13.

An embryo of 3 days 14 hours shows four ectodermic grooves and on the third gill arches there appear the first signs of external gills, small knob-like projections as shown in Figure 16 (B). The gills increase in size until about 4 hours later they appear as auricularly-shaped expansions (B, Fig. 17) of the ventral region of the third branchial arches.

The blood circulation in the external gills is simple. The third and fourth aortic loops pass through their respective gill arches and lead directly from the truncus to the radices aortae, but in the region of the gills, the third aortic loops are tapped so that the blood also flows through the gills and then back into the aortic loops at a more dorsal level.

Sections made through a 4 days 8 hours embryo (Figs. 2a and 2b) show that all four of the pharyngeal pouches come in contact with the ectoderm. In this stage, the fourth pharyngeal pouch is very small (4p) and extends only through a few sections. The gills (B) are still present. Figure 3 is a transsection through an embryo of about 7 days. The gills are now situated in a triangular pocket formed between two folds of skin in the cervical region of the embryo that meet ventrally, just anterior to the yolk. The ectodermic grooves can no longer be distinguished as such and the gills are somewhat reduced in size. In an embryo of 8 days 17 hours, the gills have almost disappeared and in an embryo of 9 days 17 hours, they can no longer be found.

Limbs

In *Eleutherodactylus portoricensis* the four limb buds do not arise in the same stage of development, as can be seen by comparing Figures 10 and 11 with Figures 12 and 13. The hind limb buds make their first definite appearance in an embryo of about 2 days 16 hours. On the other hand, the fore limbs do not arise until 6 hours later. It is only in this 6 hour interval that it becomes apparent that the hind limb buds arise first, for they alone can be definitely demonstrated when an embryo in this stage is examined. The fore limb buds rapidly attain a size comparable to that of the hind limb buds, as illustrated in Figures 14 and 15. But throughout development the latter maintain a slight increment in size over the former.

Plate I

Figs. 4 through 15 are ×16. Figs. 16 and 17 are × 22.

4. An egg showing the position of the first three cleavage planes. 5. An egg showing the position of the fourth cleavage plane. 6. Another egg in the same stage as that in Fig. 4. 7. An egg in the same as that in Fig. 5, showing six cells in the animal region, ten cells in all. 8. Another egg in the same stage as that in Fig. 5, showing seven cells in the animal region. 9. An early neural plate stage, 1 day 14 hours old embryo. 10. An embryo 2 days 16 hours old showing the posterior limb buds and the absence of the anterior limb buds. 11. Lateral view of the embryo of Fig. 10. 12. A 2 days 22 hours old embryo. 13. Lateral view of the embryo of Fig. 12. 14. A 3 days 10 hours old embryo. 15. Lateral view of embryo of Fig. 14. 16. A 3 days 14 hours embryo. 17. A 3 days 18 hours embryo.

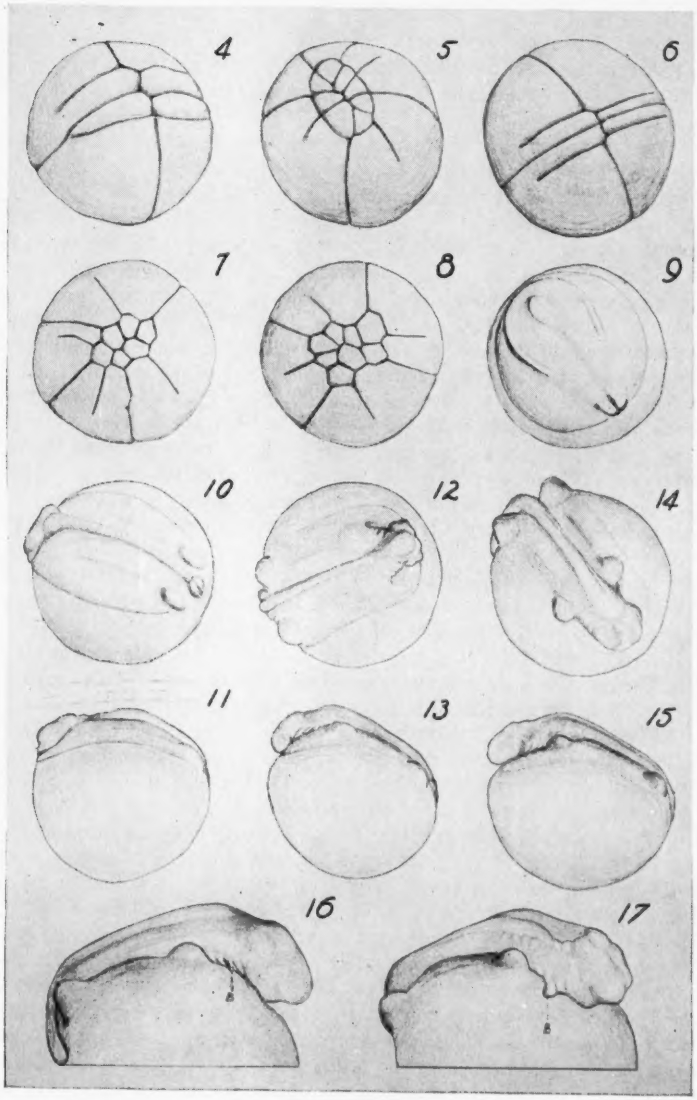


PLATE I

Tail

It has been generally accepted that the tail of *Eleutherodactylus* is respiratory in function. When fully developed, the tail is large, membranous, well vascularized and in position lies against the inner surface of the vitelline membrane. As a consequence, it is highly probable that the tail does carry on respiration.

The tail begins as a knob-like formation just above the anus and as it develops it lengthens, turning to the right or left of the embryo (Fig. 14) between the embryo and the egg membranes. The flexure to the right or left thus formed is quite rigid, as evidenced when the embryo is stimulated to motion. During such activity on the part of the embryo, the tail maintains its original flexure. The rigidity of this bend in the embryonic tail aids in keeping the tail away from the surface of the egg membranes, an important factor in embryo rotation, which will be discussed below. In later stages, however, when the tail reaches a considerable size, the flexure or bend gradually disappears and the region acquires the flexibility of the rest of the tail.

The tail gradually becomes membranous as the cutis dorsal and ventral to the notochordal support expands until finally the tail assumes a cup-like shape, the dorsal portion of the membrane being smaller in area than the ventral region. While the embryo is in the egg, the tail curves over the right or left side of the embryo, usually somewhat ventrally, but occasionally somewhat dorsally instead. Once fully developed the tail remains so until several hours before hatching, at which time it diminishes in size. When released from the egg membranes, the little frog still possesses a tail, but this is rapidly absorbed. In an hour or two, the organ is very much reduced and 24 hours after hatching little, if anything, of the tail can be seen.

In some individuals, the tail degenerates early during development so that it remains as a shrunken and deformed mass of tissue. This condition, however, does not interfere with the growth and differentiation of the embryo.

As an experiment, a number of embryos beyond the 3 days old stage were released from the egg membranes into ordinary spring water; stages younger than 3 days old were not tried, due to a lack of material at the time. When the embryos were released in the early stages around three to four days old, they grew at a much faster rate than did normal embryos from the same cluster. When released in the later stages of development, an increase in the rate of growth was not noticed. It is possible that the increment in growth rate is present in these, but since the time of exposure to the new environment is far shorter than that of embryos released in earlier stages, the effect would be correspondingly smaller and may pass unnoticed.

In all the experimental embryos, the tail developed normally except that it was directed posteriorly when grown instead of being curved about the embryo. When the embryo is removed from the egg membranes only 2.5 days before hatching, however, some odd results are obtained. If a normal embryo in this stage is disturbed mechanically or by strong light, it goes through a short period of vigorous activity. An embryo released in this stage is also active under such stimulation, but the tail membrane begins to curl and shrink rapidly until it is only a small fraction of its original size. When left undisturbed and in a dark place, the tail membrane expands to its original size.

Rotation

Another interesting feature about the development of *Eleutherodactylus* is the fact that the embryo rotates on a dorso-ventral axis passing through the center of the egg. Rotation begins in the early neural plate stage of embryonic development shown in Figure 9. The rotation may be clockwise or counterclockwise about the axis and in embryos from the same cluster, some will be going in one direction and the remainder in the other. The rate of rotation also varies not only from cluster to cluster and stage to stage, but from egg to egg as well. The rotational direction and the rate of rotation, therefore, are individual characteristics of the embryo. A rapid rotation is about one revolution per 13 seconds; at the other limit, the embryo may seem hardly to move.

While the embryo begins rotation at about the 1 day 14 hours stage, it is difficult to determine when rotation ceases. At about the 5 days 3 hours stage, to all appearances rotation ceases; but when the embryo is disturbed and actively moves its limbs and tail, it rotates on its axis for a few moments after quieting. Two significant facts were noted, however; first, rotation slows and ceases when the tail has finally become so large as to create friction against the egg membranes. It must be remembered that the point of flexure mentioned above keeps the tail from the membrane surface during the early stages. Second, in several series, eggs at about the 5 days 3 hours stage were collected in such a dehydrated condition that the embryo was so closely applied to the inner membrane surface that rotation was totally impossible and the embryo was growing under cramped conditions. When the eggs were placed in water, the water diffused through the membranes so rapidly that the egg swelled to normal size before the embryo could relax from its cramped condition. Rotation started almost immediately and then stopped 30 minutes later when the tail relaxed to such a position that it scraped against the vitelline membrane.

It thus seems that the embryos in the later stages have what may be termed a potential rotational capacity, but due to the friction of the embryo against the egg membranes, rotation ceases as such though its mechanism still functions. What the mechanism of rotation is, I don't know, but it should be kept in mind that this mechanism starts in an early neural plate stage, possibly sooner, and continues for several days of embryonic development. Another significant point is that the direction of rotation is constant—an embryo rotates in a given direction until rotation definitely ceases.

Cilia as the source of rotation could not be found in my preparations.

Rotation is not to be found in embryos released from their egg membranes into spring water.

Summary

1. There is no definite breeding season and there is no evidence to show that there actually exists parental care of the young by either the male or the female of *E. portoricensis*.

2. The segmentation is holoblastic. The first two cleavages appear at right angles to each other and pass through the two egg poles. The third consists of two planes at right angles to the first cleavage plane and parallel to

the second. The fourth is at right angles to the first three and appears at a distance about two thirds of the way up from the equator.

3. There are present two external gills, one on each side of the third gill arches. The gills have a circulation detoured directly from the third aortic loops. No gill slits appear during development, although there are four pairs of branchial grooves and four pairs of pharyngeal pouches.

4. The four limb buds do not emerge simultaneously, the hind limbs appearing about 6 hours before the fore limb buds become noticeable.

5. Respiration is carried on jointly by the tail, the skin, and the external gills.

6. Rotation around a central dorso-ventral axis is present. The rotational characteristics are individual in nature and one embryo may differ from another in the rate and direction of rotation.

7. The development of *E. portoricensis* occupies 17.5 to 19.5 days.

Literature Cited

Bavay, A.

1873a Note sur embryons de l'*Hylodes martinicensis*. Extrait d'une lettre. *C. R. Acad. Sci. Paris*, 77: 788–89.

1873b Note sur l'*Hylodes martinicensis* et ses metamorphoses. *Ann. Sci. Nat.*, (5) 17, art. 16: 1.

1873c Sur l'*Hylodes martinicensis* et ses metamorphoses. *Jour. Zool.*, 2: 13–21.

1873d [A note by Meyer.] *Zool. Gart.*, 14: 356.

Bello y Espinosa, Domingo

1871 Zoologische Notizen aus Puerto Rico. *Ibid.*, 12: 351.

Montgomery, T. H.

1901 Peculiarities of the terrestrial larva of the urodelous batrachian, *Plethodon cinereus* (Green). *Proc. Acad. Nat. Sci. Phila.*, 53: 503–508, pl. 30.

Peters, W. C. H.

1876 Über eine von Hrn. Vicecounsul L. Krug und Dr. J. Gundlach auf der Insel Puertorico gemachte Sammlung von Saugethieren und Amphibien, so wie über die Entwickelung eines Batrachiers, *Hylodes martinicensis* Dum. Bibr., ohne Metamorphose. *Monatsber. Akad. Wiss. Berlin*, 1876: 703–714, pl. 1.

Sampson, L. V.

1904 A contribution to the embryology of *Hylodes martinicensis*. *Amer. Jour. Anat.*, 3: 473–504, pl. 1–2.

Schmidt, K. P.

1927 A new tree-frog from Porto Rico. *Amer. Mus. Novit.*, 279: 1–3.

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Parturition in the Yucca Night Lizard

By R. B. Cowles

THERE seems to be no recorded information on births of *Xantusia vigilis* beyond the statement of Vandenburgh (1922) that on returning from a collecting trip in September he discovered more specimens of *Xantusia* than he had collected. From this information he correctly deduced that the species

was ovoviviparous. Herpetologists in southern California are now thoroughly familiar with the fact that young night lizards are frequently born while they are being carried en route home from collecting trips taken in late August, September, and—more rarely—in early October.

The fact that no report on the actual circumstances of birth are available may be ascribed to the phenomenal rapidity with which the animal accomplishes the act of birth. The actual expulsion of the foetus requires about one minute from its first appearance until separation from the parent. A chronological account of the details in a typical case reveals the following salient features.

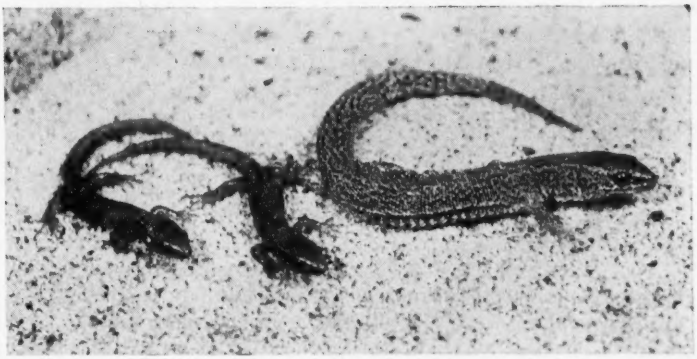

Fig. 1. Adult female and newly born twins. Note lateral folding, an invariable trait of parent after parturition.

Prior to birth, the female appears somewhat more restive than normal. This period of unrest may begin some twenty or twenty-five minutes prior to giving birth to the young, and involves many backward movements and a licking of the mouth, and also of the spectacle of the eye. None of the acts described nor all of them together provide an inevitable warning of the approaching event. The first reliable symptom of parturition "birth pains" appears to be an elevation of the femora to a nearly vertical position, so that they assume a marked "V" posture. This elevation of the legs may be repeated several times, and probably indicates the stretching of the pelvic and associated muscles. Just prior to birth the legs are maintained in this elevated position for as much as three minutes, but they are lowered just before the expulsive movements become evident.

During actual birth the legs are returned to the normal position and support the body and vent well above the ground. At this time the body of the parent is strongly flexed, so that the snout almost touches the vent. In this position the foetus, with its enveloping membrane, is partially protruded. When the membranes appear the mother grasps the foetal envelope in her teeth and rips it open. This action seems to activate the young. In any event, the violent struggles that follow release the tail and hind legs of the foetus.

The young are extruded tail, or rather breech, foremost, and back down. Thus the aimless grasping movements of the hind limbs and the thrashing of the tail result in engaging these members about the base of the parent's tail. If the young pauses in its struggle, the mother may, and usually does, nip the young on the exposed flank and leg. This appears to act as a stimulant and the young thrash violently and by their contortions extricate themselves from the parental cloaca. As they touch the ground they right themselves and run to a distance of 2 or 3 inches.

Since the young leave the foetal membranes within the cloaca, these must be extracted; the parent grasps the protruding membranes in her mouth, gradually draws them out and swallows them. After removing the egg case and its contained liquids, she licks up any droplets of fluid that may have fallen to the ground, and resumes a normal posture. This entire procedure from the moment the foetal membranes appear at the opening of the cloaca until all visible traces of birth have been removed, requires about two minutes.

Twins have been observed in seven of the eleven births that have taken place in this laboratory. The remaining individuals gave birth to only a single offspring.

The average length of the parent from snout to vent is 40.5 mm., with a maximum 41 mm., and minimum 39 mm. The average snout to tail-tip length of the young is 49.33 mm. with a maximum of 51 mm., and a minimum of 47 mm. The largest foetus, 51 mm., was born from the smallest parent.

Five of the parents have been maintained in captivity since May 15, at a mean temperature of 26.5° C., with fluctuations of short duration ranging from 22° C. to 31° C. More than 90 per cent of the time the temperature has remained at approximately the indicated mean. Throughout the entire period of captivity all of the specimens have been fed on termites. Freshly captured individuals have given birth to young at the same time as these captive specimens, and it is assumed that both the diet and temperature requirements have approximated those for the normal conditions. The births observed in the captive series took place between September 4 and September 19.

The captive females may have been inseminated prior to the date of capture, May 15, 1943. Spermiogenesis, as indicated by sectioned testes, was initiated about April 19. Spermatozoa that appeared to be mature were observed prior to May 18, but they were not in sufficient numbers to represent normal reproductive activity. The height of spermiogenesis was reached on June 3, and by June 15 epididymal tubules were crowded with sperm.

Insemination of the captive specimens must have been before the females were segregated. It may therefore be considered that insemination took place about May 15. With this approximate date of fertilization, it would appear that the period of gestation is about four months.

Literature Cited

Van Denburgh, John
1922 The reptiles of western North America. . . . I. Lizards. *Occ. Pap. Calif. Acad. Sci.*, 1 (10): 1–611, pl. 1–57.

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A New Skink from the Sierra Nevada of California

By Thomas L. Rodgers

In the course of recent studies of skinks of the genus *Eumeces*, 57 specimens of *E. gilberti* were collected in the northern Sierra Nevada of California, the extreme northern part of the range of the species. Examination of these specimens and 25 others from this section already at hand discloses the presence there of a race distinct from *E. g. gilberti*. Taylor, in his revision of the genus (1935: 428–431), applied the name *E. skiltonianus brevipes* Cope to specimens from this area. He justified this usage of *brevipes*, a name Cope (in 1900) had applied to a skink collected at Fresno, Fresno County, within the range of *E. g. gilberti*, by assuming that the type of *brevipes* was not collected at Fresno but somewhere north of there. He was apparently led to this assumption by the fact that the type shows traces of dorsolateral lines, a character not typical of adult *gilberti* but typical of skinks from Eldorado County. However, studies of geographic variation within the race *gilberti* indicate that Fresno lies at the northern edge of the area of intergradation between *gilberti* and *rubricaudatus* and that the intergrades often exhibit this character. Further evidence is contained in a letter from Dr. Gustav Eisen, the collector of the type of *brevipes*, who states that he "collected skinks in Fresno County and nowhere else." Thus, *brevipes* of Cope must be considered a synonym of *gilberti* and the race to the north is left without a name. For the name of this race I propose

Eumeces gilberti ***placerensis,*** new subspecies

Plestiodon skiltonianum Baird and Girard, Grinnell and Camp, Univ. Calif. Publ. Zool., 17, 1917: 175, 176.

Eumeces skiltonianus brevipes Cope (of Taylor, not Cope), Taylor, Bull. Univ. Kans., 23, 1935: 428–31.

Type.—Adult male, No. 24058, Mus. Vert. Zool., collected by H. S. Fitch, 6 miles east of Smartville, Nevada County, California, May 6, 1937; original No. 3380.

Range.—Foothills of Sierra Nevada, below 2500 feet, in southern Yuba, Nevada, Placer, Sacramento, Eldorado, Amador, and San Joaquin counties, and on the valley floor east of the San Joaquin River in San Joaquin County.

The northern limit of the range is the south bank of the Yuba River, on the north bank of which *E. skiltonianus* occurs. The range of *skiltonianus* extends south of the Yuba River at 4000 feet elevation in Placer County. It may be found that *placerensis* and *skiltonianus* occur together somewhere above 2500 feet in this area. No skinks of any kind have yet been found inhabiting the part of the Sacramento Valley that borders the western edge of the range of *placerensis*, although *placerensis* itself extends onto the valley floor in San Joaquin County. In Calaveras, Stanislaus, and Tuolumne counties, *placerensis* intergrades with *gilberti*.

Racial Characters.—Bright blue tail color of young retained until the individual has reached a snout-to-vent length of 60-65 mm.; dorsolateral and lateral lines sharply defined in young and in young adults (especially females); some trace of color pattern of back and sides retained in all females

(only on sides in largest females), and in all except largest (snout-to-vent length greater than 92 mm.) adult males; scales of dorsolateral light lines possess distinct dark margins. Adults reach maximum size (snout-to-vent length) of 108 mm.; no sexual dimorphism in size and little or none in limb length; limbs relatively short (see table). Seven supralabials present slightly more commonly than 8 (Fig. 1, A); 1 pair of nuchals much more commonly than 2 (Fig. 1, B); average count of 61 scales (58–64) from occiput (including nuchals) to base of tail (posterior edge of thigh).

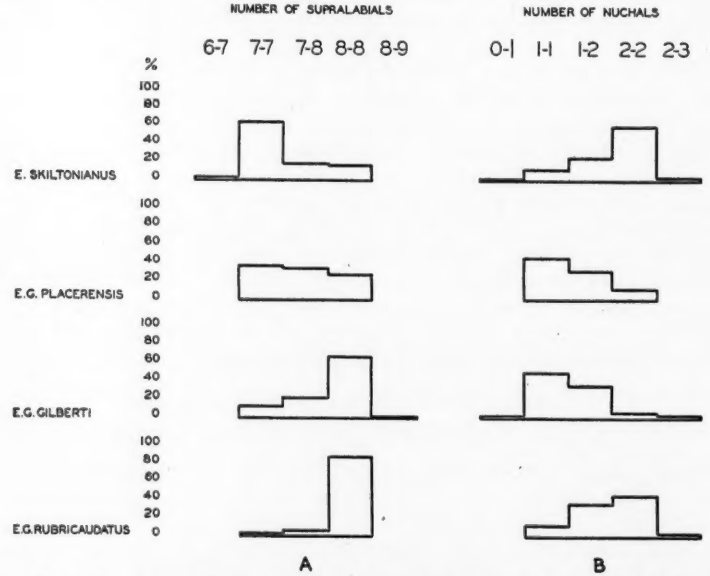

Fig. 1. Comparison of the percentage occurrence of numbers of supralabials (A) and nuchals (B) in *E. g. placerensis* with related kinds of skinks. The horizontal position of the different columns indicates the condition of the supralabials or nuchals, for example: $7 - 7 = 7$ supralabials on each side, $7 - 8 = 7$ on one side and 8 on the other, $1 - 1 = 1$ pair of nuchals, $1 - 2 = 1\frac{1}{2}$ pairs. The number of specimens represented here is roughly the same as in the scale count data in the table.

Comparison with Other Forms.—The race *placerensis* most nearly resembles *E. g. gilberti*, but in some respects it approaches *E. skiltonianus*. It resembles *gilberti* in its large size, relatively short legs, failure to retain juvenal tail color into adulthood, sexual dimorphism in retention of color pattern, eventual complete loss of color pattern in males, possession of dark edging on scales of dorsolateral light lines, possession of 1 pair of nuchals more commonly than 2, and possession of large average number of scales in a line from occiput to base of tail. It differs from *E. g. gilberti* in longer retention of juvenal tail color (probably into second year in *gilberti* and third year in *placerensis*), longer retention of the color pattern (see above), in having 7 supralabials more often than 8, and in having less sexual dimorphism in adult

color pattern and snout-to-vent length. In these ways, it approaches *E. skiltonianus* (*E. skiltonianus* never completely loses the color pattern, and exhibits no sexual dimorphism in adult color pattern or snout-to-vent length). Further, *placerensis* differs from both *gilberti* and *skiltonianus* in having no sexual dimorphism in relative limb length.

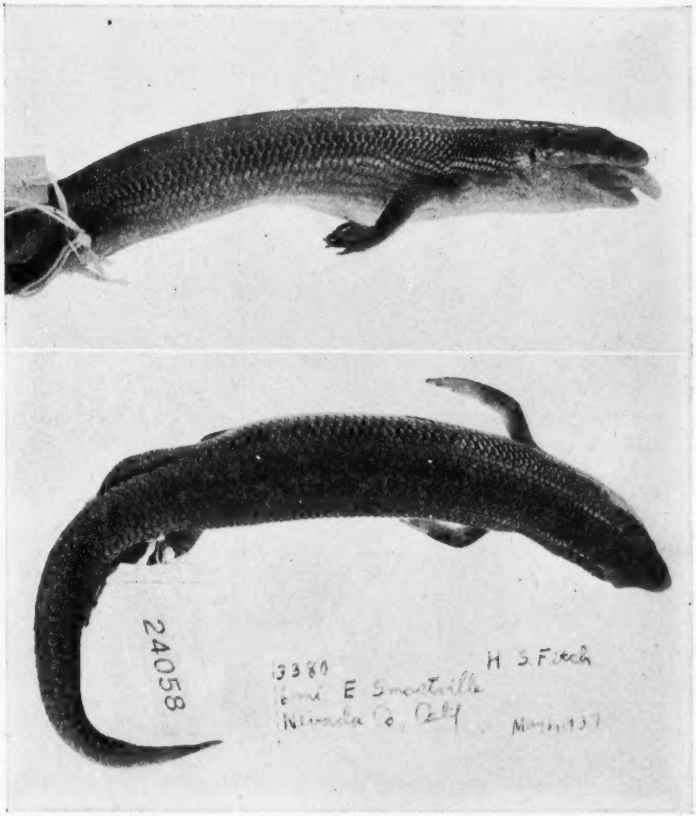

Fig. 2. Dorsal and lateral views of the type specimen of *Eumeces gilberti placerensis*, new subspecies. Adult male, No. 24058, Mus. Vert. Zool.

REMARKS.—The only specimens included in the series used for comparisons of size and proportions were those known to be more than one year old. Since there is known to be age variation in such characters, it would have been better to select only adult (three-year-old) specimens, but this was not possible. The result is that the averages are slightly lower than they would be for adults, and that the minima presented for these characters are approximately those for a 13 or 14 month-old specimen. Since there was no age

difference found in scale counts, specimens of all sizes were used in such comparisons.

MEASUREMENTS AND PROPORTIONS OF *E. g. placerensis* COMPARED WITH THOSE OF RELATED KINDS OF SKINKS

			skiltonianus	*g. placerensis*	*g. gilberti*	*g. rubricaudatus*
Snout-to-vent length measurements in millimeters	Males	mean and σ_m	**62.7 ± .42**	**89.6 ± 2.2**	**91.3 ± 1.4**	**86.5 ± 1.2**
		(min.-max.)	(45.6—82.9)	(66.4—103.2)	(66.7—107.7)	(67.3—113)
		no. of spec.	166	23	59	40
	Females	mean and σ_m	**63.2 ± .48**	**86.5 ± 2.4**	**82.4 ± 1.1**	**88.1 ± 1.3**
		(min.-max.)	(45.7—80.5)	(62.6—108.1)	(70.0—95.2)	(71.1—107)
		no. of spec.	134	21	31	18
Length of hind limb as per cent of snout-to-vent length	Males	mean and σ_m	**38.0 ± .13**	**35.7 ± .27**	**36.2 ± .2**	**38.0 ± .33**
		(min.-max.)	(34.0—44.2)	(33.0—39.0)	(32.7—39.8)	32.0—41.9)
		no. of spec.	152	21	56	34
	Females	mean and σ_m	**35.7 ± .19**	**34.6 ± .44**	**34.6 ± .28**	**35.4 ± .46**
		(min.-max.)	(30.8—40.8)	(31.2—38.3)	(31.0—37.8)	(31.0—39.6)
		no. of spec.	108	20	31	16
Length of forelimb as per cent of snout-to-vent length	Males	mean and σ_m	**26.3 ± .09**	**24.2 ± .31**	**24.8 ± .13**	**26.3 ± .31**
		(min.-max.)	(23.2—29.4)	(22.4—26.8)	(22.3—27.1)	(22.1—30.9)
		no. of spec.	151	21	56	34
	Females	mean and σ_m	**25.0 ± .11**	**24.6 ± .13**	**23.7 ± .14**	**24.6 ± .28**
		(min.-max.)	(22.2—28.9)	(22.4—26.7)	(22.0—24.8)	(20.6—27.4)
		no. of spec.	106	23	31	16
Number of scales from occiput to base of tail	Males	mean and σ_m	**57.8 ± .07**	**60.8 ± .19**	**60.9 ± .17**	**61.1 ± .15**
		(min.-max.)	(51—62)	(58—63)	(58—64)	(58—63)
		no. of spec.	253	50	73	49
	Females	mean and σ_m	**58.8 ± .09**	**61.5 ± .23**	**61.0 ± .21**	**62.0 ± .26**
		(min.-max.)	(54—62)	(59—64)	(58—64)	(60—65)
		no. of spec.	191	32	48	24

Activity and Winter Changes of Hatchling *Pseudemys* [1]

By Fred R. Cagle

RESEARCHES on the growth of *Pseudemys scripta elegans* in southern Illinois have necessitated the study of the hatchlings. Eggs removed by dissection and incubated at room temperature hatched during the last of August and the first of September, and it was assumed that hatchlings could be collected in the field during the latter month. Intensive hand collecting in shallow areas of lakes during August and September of 1938, 1939, and 1940 yielded only 2 hatchling *Pseudemys* although many young *Chelydra* and *Sternotherus* were collected. Similar collecting during spring of the same years yielded many hatchling *Pseudemys*. On May 5, 1941, 41 were collected in a few hours from one mudflat.

Spring collected hatchlings often retain the egg tooth and have the navel incompletely healed. Two collected April 27, 1940, still retained egg tooth stubs and large internal yolk balls, one measuring in mm. 8 x 5 and the other 4 x 3. The navel was not healed in either. A third, collected May 2, 1939, crawling laboriously up a clay bank several hundred feet from the water, was so encumbered with wet clay that it could hardly move. An egg tooth stub was evident and the umbilical scar was not yet formed. Two others were collected under similar conditions. One collected May 19, 1940, on the top of the earthen dam at the Carbondale city lake retained the egg tooth, as did another collected near the Big Muddy River. These turtles had apparently just vacated winter nests and were seeking water.

Hatchlings were collected from the water during the last of April and throughout the spring but very few were found previous to the first of May in spite of intensive collecting. On March 23, 1940, an aggregation of juvenile turtles was found at the city lake. It was a cloudy, cold day, air temperature 20° C., water temperature 5° C. A strong wind from the north was washing considerable plant debris onto the south shore. Two workers, muddling for turtles for two hours, failed to obtain a single one until a mass of wave-piled debris was kicked onto the shore. Examination of a section of this yielded 11 *Pseudemys*, 2 *Chrysemys*, 6 *Sternotherus*. The *Pseudemys* were all in their second season of growth (as attested by growth rings). Any hatchlings present in that part of the lake should have been easily found.

Fifteen hatchlings, collected from masses of algae at the city lake May 14, 1941, showed no evidence of growth and had definite egg tooth scars and unhealed navels. Ten hatchlings showing slight growth and with the navel well healed were collected from a mine pond near Herrin, May 19, 1940.

Since no information was available as to the length of the period elapsing between hatching and the healing of the navel, loss of the egg tooth and the initiation of growth, the above records could not be used to determine the time of leaving the nest or the length of the period since hatching. Efforts have now been made to obtain information on the length of time the egg tooth is retained and the time required for the umbilical scar to form.

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1 This report was prepared under the direction of Dr. Norman Hartweg to whom I am grateful for criticisms and suggestions.

Turtles hatched in the laboratory September 13 had retracted all of the yolk sac and the umbilicus was closed by September 16. The egg tooth was still present. Fifteen *Pseudemys* hatched September 12 and kept in moist wood rot still retained the egg teeth on September 16 when they were moved to an aquarium. The egg teeth remained until September 27, when 12 turtles had lost them, 2 retained stubs and that of another came off when it was touched during the examination.

This period of egg tooth retention is probably somewhat different from that under field conditions. However, with the information on the egg tooth retention of turtles in the winter nest to be described, it does emphasize that the egg tooth may be retained until the turtle moves ino the water and even for a few days thereafter. It appears certain that we may conclude that any turtle with an egg tooth found in the water has recently entered the water for the first time.

My data indicate that hatchlings are not present in any abundance in the water until after the first of May and that many of the turtles collected then have recently left winter nests. Cahn (1937: 168) states that in the vicinity of Meredosia, on the Illinois River, the young hatch toward the end of August or early in September and immediately go directly to the nearest water, where they remain in the vegetation-choked shallows.

Further verification of over-wintering in the nests was sought and plans were made to observe nests throughout the winter. Several nests were marked during September of 1939 but predators destroyed all but two. Both of these, located in a clay hillside near the Carbondale city lake, contained 6 turtles that were removed from the nest and weighed, measured, marked, and returned. The clay nest plugs were removed and replaced intact. The turtles had obviously been hatched for several days as the yolk sac had been completely retracted and the umbilical opening partly closed. The egg tooth was present in all.

The nests were examined three times during the period September 15 to October 4. Previous to October 1 the turtles would undoubtedly have experienced difficulty in escaping as the soil in the vicinity was dry and hard packed. On October 1 the ground was softened by a rain that loosened the clay walls and the nest plugs, but all the turtles were still present on October 4, when 2 were removed from one of the nests for study.

On October 26 one of the nests was empty. The young had apparently left of their own accord, as a slanting hole of the approximate width and height of a hatchling had been dug from the nest upward along one side of the clay plug. Careful search of the vicinity and of shallow water near the nest yielded no evidence as to where the turtles had gone.

It was noted on October 4 that the burrow of a mole had penetrated this first nest and thus disrupted its structure. Possibly the cold air entering the nest via the open burrow impelled the young turtles to seek the protection of the water.

All were still present in the second nest on October 26. This remaining nest was observed from the surface repeatedly during October and the first two weeks in November, but was not opened until November 19. All turtles were still present and moved feebly when disturbed. The temperature of the

soil in the bottom of the nest was 10° C.; air temperature 2° C. On December 9, when the nest was again examined, all turtles were present and all still retained the egg tooth.

On December 11, one individual was removed from the nest for study. The egg tooth was present but came off within a few minutes after the turtle was placed in an aquarium. Dissection indicated that the yolk ball was almost completely resorbed.

The ground in the vicinity of the nest, January 4, was covered with 8 inches of snow and the soil frozen to a depth of half an inch. Temperature of the soil at the bottom of the nest was 1° C. February 22 the nest was flooded by water that washed through and loosened the nest plug. The soil temperature was 3° C.

The nest was not reopened until March 2 when the temperature of the soil at the bottom of the nest was 16° C. On March 22 one hatchling still retained the egg tooth but the remaining 2 had lost it. The soil temperature was 5° C. The nest was not examined again until mid-April, by which time the turtles had left. This was probably an unusually early emergence.

The records of this nest and the other data presented indicate that turtles commonly over-winter in this region. A correspondent from Reelfoot Lake, Tennessee, who has had much experience in collecting hatchling *Pseudemys*, reports that about half of the young turtles emerge in the fall and half the following spring.

TABLE I

RELEASE-RECOVERY DATA ON 4 HATCHLING TURTLES

No.	Date	Days	Dimensions in millimeters				
			C. l.	C. w.	P. l.	P. w.	Ht.
405	9/18/39		30	28	28	16	16
	10/ 7/39	19	31	30	29	15	13
412	9/11/39		32	29	31	16	17
	5/18/40	249	32	31	31	16	15
430	9/11/39		30	30	29	16	16
	6/ 5/41	632	45	45	43	24	21
439	9/16/39		30	30	29	16	15
	2/21/41	523	90	52	55	28	26

The habit of over-wintering in the nest has not been previously reported for *Pseudemys*, but is known for other species. Nichols (1933: 42) observes that the young of the painted turtle (*Chrysemys picta*) may hatch in the fall but do not emerge from the ground at that time. Toner (1940: 265) reports a winter nest of the snapping turtle (*Chelydra serpentina*). Newman (1906: 141) reports the frequent discovery of newly-hatched *Graptemys* during May and June. He points out that the eggs of the occasional females that nested during the latter part of July would not have time to hatch before winter and that the embryos must pass the winter in a condition of dormancy. He further states (*Ibid.*: 145) that the same may be true of *Chrysemys*.

The records of three hatchling turtles marked and recovered indicate that such individuals may spend the winter season in the nest or in the water without fatal injury. No. 430, one of the 6 turtles marked in the winter nest, was recovered June 5, 1941, 632 days after its release, from the water near the nest (Table I). Two of a group of hatchlings released in the water during September, 1939, were subsequently recovered, one on October 7, 1939, and the other in the early spring of 1940.

These recoveries provide some information on changes in the hatchlings during this first winter. No. 405, released for only 19 days, exhibits some changes in the carapace and plastron proportions (Table I). The height of the carapace was reduced 3 mm., accompanied by widening (2 mm.) and elongation (1 mm.) of the carapace. No. 412, released for 249 days in the winter of 1939-1940, reduced the carapace height 2 mm. and increased its width 2 mm. with no changes in other linear measurements. Similar changes were observed in individuals retained in aquaria during the winter. They are accompanied by a general increase in firmness of the carapace and plastron, resorption of the yolk, loss of the egg tooth and healing of the umbilicus.

Further information on over-winter changes may be obtained by comparing hatchlings 24-28 hours old with those collected in the field before the beginning of the growing season in the spring (Table II). If the difference between the means is considered significant when it is greater than 2.7 times its standard error, the increase in mean carapace length and mean carapace width is of significance. The change in mean height, mean plastron length, and mean plastron width is not significant.

TABLE II

A COMPARISON OF THE DIMENSIONS OF SPRING-COLLECTED HATCHLINGS WITH THOSE OF TURTLES 24-48 HOURS OLD

Dimension	24–48 hours old				Spring-collected			
	Range	M.	S. D.	S.E.	Range	M.	S. D.	S.E.
Carapace l.	26.5–35.0	31.3	1.91	.24	24.5–37.5	32.6	2.71	.39
Carapace w.	24.2–34.0	29.8	2.04	.25	25.0–35.6	32.5	2.23	.32
Height	13.5–17.8	15.9	1.18	.15	11.5–17.3	15.3	1.37	.20
Plastron l.	24.5–33.0	29.8	2.00	.24	24.1–35.1	30.6	2.42	.35
Plastron w.	11.5–19.5	16.8	1.14	.14	15.0–18.6	16.8	0.96	.14

Agassiz (1857: 292) states that there is very little difference between turtles recently hatched and those collected in the spring. Hildebrand and Hatsel (1926: 14) state that terrapin hatchlings (*Malaclemys centrata concentrica*) may spend the winter in a state of dormancy and that by spring they are slightly smaller than when first hatched.

LITERATURE CITED

AGASSIZ, LOUIS

1857 Contributions to the natural history of the United States of America, 2: 451–643.

CAHN, ALVIN R.
1937 The turtles of Illinois. *Univ. Ill. Bull.*, 35: 1–218.
HILDEBRAND, S. F., and CHARLES HATSEL
1926 Diamond-back terrapin culture at Beaufort, N. C. *Bur. Fish. Econ. Circ.*, 60: 1–20.
NEWMAN, H. H.
1906 The habits of certain tortoises. *Journ. Comp. Neurol. and Psychol.*, 16: 126.
NICHOLS, J. T.
1933 Further notes on painted turtles. COPEIA, 1933: 41–42.
TONER, G. C.
1940 Delayed hatching in the snapping turtle. *Ibid.*, 1940: 265.

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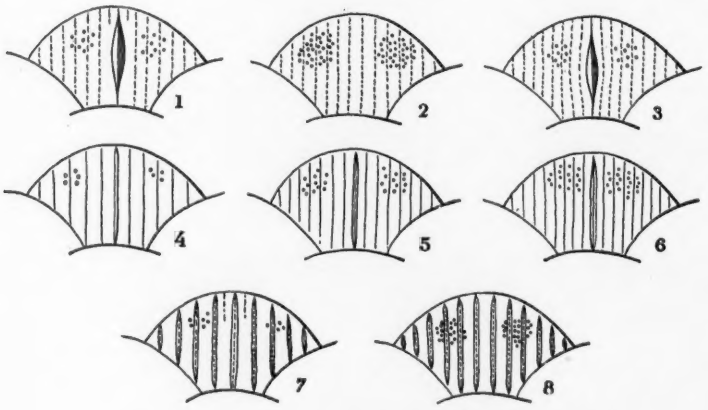
Scale Structure in Jamaican Lizards of the Genus *Celestus*

By CHAPMAN GRANT

A PERSON who looks at a scale of a lizard of the genus *Celestus* through a microscope will be astonished at the complicated structure revealed. The bony plates imbedded in the scales of lizards of various families, especially the Scincidae, have been known for a long time. Cuvier (1845) is quoted by Bocourt as saying that skinks have scales not merely like those of serpents, which are projections of the dermis covered by transparent epidermis, but 'real calcareous secretions' in a fold of skin. Emile Blanchard (1860) (also as reported by Bocourt) regards the formation of the plates as an aid in respiration although he gives no reason for such a supposition. His excellent plate shows the "air tubules and bony corpuscles." Bocourt (1881) goes into the matter in more detail, figures various types of scales, and uses the structure for taxonomic purposes. He states that the similarity of skinks is due to ecological conditions so one must look further than mere form for proper classification. He introduces the use of scale structure for this purpose. He says that Cuvier was the first to note the peculiar scales, but that the minute structure had only recently been described. He quotes

Blanchard (1860) as having called attention to the same thing and to the rôle of the tubules in respiration and refers to Blanchard's plate. Bocourt describes the scales as follows. Each scale is composed of three parts; first the epidermis which is in three very thin layers, the outer being chitinous and all three pierced by tubules; the second is a pigmented layer which contains the arborescent designs; the third is the osteo-dermal plate containing the longitudinal and transverse canals or tubules.

He classified the skinks into three groups according to scales; the first group has regular and symmetrical scales with three or four longitudinal tubules springing from a transverse canal; the second group has oval scales also with a transverse canal and more numerous longitudinal canals; and the third group has circular scales with radial canals running posteriorly but not reaching the periphery of the scale. He found that regenerated tails reproduced the canals regardless of the shape of the scale. Of 52 species of the group Scincoidea (which includes the Family Anguidae of modern classification) 45 had osteo-dermal plates, and he classified the genera accordingly. Taking only that part of Bocourt's key that runs down to *Celestus* we find:



Figs. 1–8. Osteodermal plates of various species of *Celestus*.

Skin / Containing osteo-dermal plates (as opposed to those without) / . . . Aspidoscinus / irregular canals (as opposed to regular) / No (complete) transverse canal. The principal canals start from a central point and the ramifications do not reach the periphery . . . *Diploglossidae* / Celestus.

I have examined the Jamaican species of *Celestus* with the results shown in the accompanying figure. Figures 1-8 show the gross differences of the scales of certain species as revealed by the hand lens. 1, *C. occiduus hewardii* Gray, scale from mid-back. 2, Same from near tail showing the disappearance of central keel and increase in number of pores. 3, *C. duquesneyi* Grant, near mid-back. In the presence of a keel this very distinct form is close to the preceding. 4, *C. c. crusculus* (Garman). 5, *C. c. cundalli* Grant. 6, *C. c.*

molesworthi Grant. Scales from mid-back in all three. These subspecies intergrade from the hot dry southern coast, to the highlands and to the dense humid north shore respectively, showing a gradual change in the gross scale striation and pores, as in many other features. 7, *C. barbouri* Grant, near mid-back. 8, Same, near tail. The scales of this very distinct species clearly show differences from all the others. The heavy central keel seems to be confined to the long-legged group, *C. o. occiduus, C. o. hewardii* and *C. duquesneyi*. Fig. 9 is a dorsal scale of *C. o. hewardii* under greater magnification

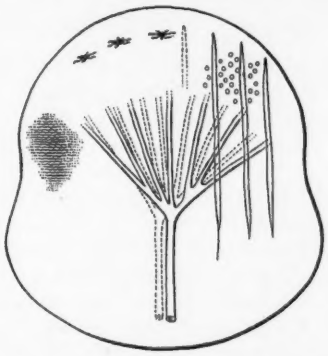


Fig. 9. Osteodermal plate of *Celestus occiduus hewardi,* more greatly enlarged.

showing samples of its specializations. At left fine sculpturing which covers entire surface; above, nuclei of calcareous or chromatin producing cells ?; right, pores and longitudinal ridges; center, remarkable pair of almost diagrammatically symmetrical hand-like tubules, supposedly for respiratory functions. Figs. 1-3 show the saw-like edges of the longitudinal ridges; Figs. 4-6 show knife-like edges; Figs: 7-8 show saw-like edges on broad bases. Fig. 9, being of greater magnification, shows the bases of the saw-like edges not shown in Figs. 1-3, and the saw-like edges are omitted from Fig. 9. The diagrams were made by Mr. Norman Bilderback, by courtesy of Clinton G. Abbott, Director of the Museum of Natural History, San Diego.

I have often wondered at the complex structure of feathers and of what a great step there was between them and reptile scales. The scales figured in this paper show such complexity that the gap is largely closed. Feathers may well have developed from some parallel case to this of *Celestus*.

Literature Cited

Bocourt, Marie-Firmin

1881 Observations générales sur la famille des Scincoidiens *in* Duméril, Bocourt, and Mocquard, Études sur les reptiles et les batraciens. *Miss. Sci. Mex.*, Pt. 3, Sect. 1, Livr. 7: 476–481, pl. 22i–22j.

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A New *Gerrhonotus* from Oaxaca

By J. A. Tihen

THROUGH the courtesy of Mr. C. M. Bogert, Department of Herpetology, American Museum of Natural History, and Mr. R. T. Moore, Associate in Vertebrate Zoology at the California Institute of Technology, Pasadena, California, I have been given the opportunity of examining several specimens of *Gerrhonotus* in the personal collection of the latter. Two of these specimens, from Mt. Zempoaltepec, Oaxaca, appear to represent an undescribed population of the *deppii* group, which I have very generously been granted permission to describe. For them I propose the name:

Gerrhonotus ***fuscolabialis***, sp. nov.

TYPE.—No. 400 in the personal collection of R. T. Moore, California Institute of Technology, Pasadena, California. An adult male, collected by Mr. Moore at Mt. Zempoaltepec, Oaxaca, between November, 1941, and June, 1942.

PARATYPE.—No. 402 in the same collection, with the same data. No additional specimens are known.

DIAGNOSIS.—A *Gerrhonotus* of the *deppii* group without protuberant supra-auricular scales; adult without conspicuous light areas laterally; chin moderately dark in color; lower labials as dark as the granular area of the neck, with indistinct lighter bands; approximately 30-31 rows of dorsal scales between the occipital and the posterior border of the thigh; dorsal osteoderms well developed; an upper anterior loreal present; sides of neck covered with more or less equal subgranular scales.

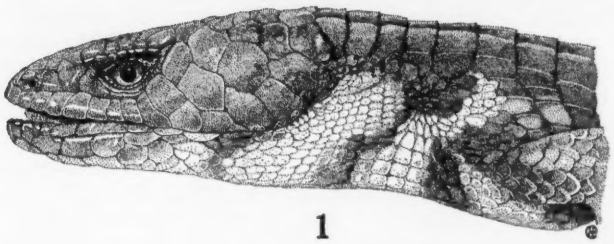
DESCRIPTION OF TYPE.—Rostral separated from the nasal by the internasals; no postrostral. Five prefrontals, the azygous one not in contact with the frontal. A small supranasal and two small superposed postnasals on each side. An upper and a lower anterior loreal, a larger posterior loreal, and one preocular on each side. Five medial and three lateral supraoculars; seven superciliaries on the left and five on the right, the most anterior one in contact with the preocular and the posterior loreal. Two suboculars and three to four postoculars. Frontal narrowly in contact with the interparietal, which is in turn in contact with the occipital; frontoparietals and parietals present. Four anterior temporals, of which the two lower ones enter the orbit; three secondary temporals. Eleven supralabials on the left and twelve on the right; the antepenultimate is the most posterior one to contact the orbit, and it has a rather characteristic shape. For further particulars of scutellation of the head, the figures may be consulted.

Fourteen rows of dorsal scales at midbody, with smaller irregular scales lateral to these, the medial rows obtusely keeled; 30 rows between occipital and posterior border of the thigh; a minimum of 6 across the nape. Ventrals in 14 rows at midbody; 59 scales between the mental and the preanals. Lateral fold very weak and almost lacking granular area; sides of neck covered with more or less equal subgranular scales.

Subdigital lamellae as follows: first finger, 7-8; second finger, 12-12; third finger, 14-15; fourth finger, 16-17; fifth finger, 10-10; first toe, 8-8;

second toe, 13-13; third toe, 18-18; fourth toe, 21-21; fifth toe, 15-15. The first of the two figures given refers to the left side, the second to the right.

Snout to vent, 118 mm.; tail, 97 mm. (broken and regenerated); head length (snout to posterior border of the ear), 29.3 mm.; head width at widest point, 22.7 mm.; head depth, 13.3 mm.; distance between the middles of the dorsal orbital borders, 11.4 mm.; internarial distance, 4.7 mm.



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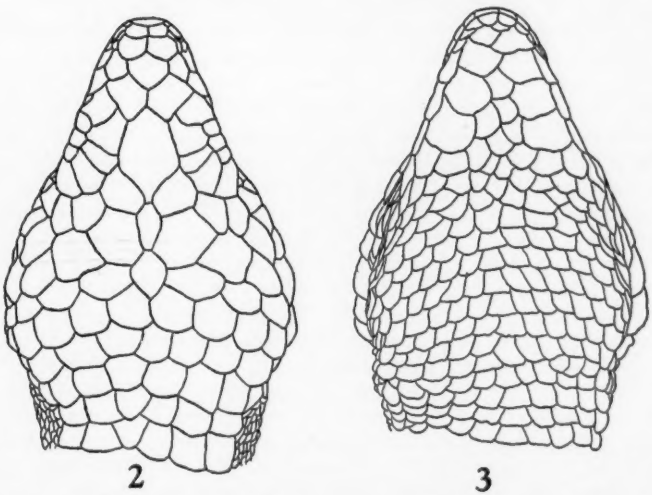

2 3

Figs. 1–3. *Gerrhonotus fuscolabialis*, sp. nov. 1. Lateral view of head and neck of type specimen. 2. Dorsal view of head of type specimen. 3. Ventral view of same. Drawings by H. P. Chrisp.

Coloration in general similar to that of *G. gramineus*. Dorsal surface of the body and limbs (in alcohol) a dark blue-gray, each dorsal scale with a blackish-brown area basally, this area being somewhat more extensive on the median than on the lateral scales. Limbs indistinctly barred or reticulated. No light-tipped lateral scales. Ventral surface of the body and limbs a somewhat lighter blue-gray, the belly darker than the chin and throat.

Infralabials distinctly darker than the chin, with narrow indistinct light vertical bands. Granular area of the neck about the same color as the belly, with a dark blotch around the insertion of the forelimb and with an oblique dark bar from the mid-dorsal border to below the ear. No sharp distinction between the color of the granular area and that of the infralabials, chin, and throat.

DESCRIPTION OF PARATYPE.—This specimen agrees perfectly with the holotype with the following exceptions: There are seven superciliaries and eleven supralabials on each side. Thirty-one rows of dorsals between occipital and posterior border of the thigh; 56 scales between the mental and preanals; the tail is complete, with 88 whorls of scales. Subdigital lamellae: first finger, 7-7; second finger, 11-11; third finger, 15-16; fourth finger, 15-16; fifth finger, 11-10; first toe, 8-8; second toe, 12-12; third toe, 18-17; fourth toe, left broken, 20 on the right; fifth toe, 15-16. Snout-vent length, 114 mm.; tail, 164 mm.; head length, 29.0 mm.; head width, 23.3 mm.; head depth, 15.2 mm.; interorbital distance, 11.1 mm.; internarial distance, 4.6.

REMARKS.—This species appears to be most closely related to *Gerrhonotus gramineus;* it is quite possible that future collecting in intervening areas will show *fuscolabialis* to be a subspecies of that form, but assumption of such a relationship is not warranted on the basis of the material at hand. From *gramineus, fuscolabialis* may be distinguished chiefly by the coloration of the chin and lower labials. In *gramineus* these areas are very light, with occasionally a few scattered blotches; the relatively dark granular area of the neck (which lacks the darker markings found in *fuscolabialis*) is in sharp contrast with the light infralabial area, the line of demarcation being at the level of the ear. No *gramineus* is known with as many as 31 scale rows between the occipital and the posterior border of the thigh, the maximum being 30 and this found only rarely; this would seem to constitute a valid, though not mutually exclusive, character for the separation of the two forms. The minimum number of scales across the nape is usually (about 75% of the time) less than 6 in *gramineus,* and an upper anterior loreal occurs only rarely in that species. The Oaxacan form would also appear to be somewhat the larger; the maximum snout-vent measurement observed in nearly 100 *gramineus* is 111 mm., whereas both of these specimens exceed that length.

I have seen no specimens of the inadequately known *Gerrhonotus oaxacae* Günther, but to judge from the published descriptions and figures *oaxacae* differs from *gramineus* almost exclusively in the lack of a large subgranular area on the sides of the neck. In that respect *fuscolabialis* resembles *gramineus* and the other members of this group excepting *deppii.* There seems to be no basis for assuming any particular difference in color pattern between *oaxacae* and *gramineus.* Günther's figure shows one specimen of *oaxacae* as having 30 dorsal scales between the occipital and the posterior border of the thigh, so it may be comparable with *fuscolabialis* in that respect. The figure also shows the penultimate supralabial in contact with the orbit; if this is the normal condition, it is in opposition to that usually found in *gramineus* and in *fuscolabialis,* where the antepenultimate is normally the most posterior to enter the orbit. The exact provenance of Günther's species is uncertain, but it is well to remember that there are several biotic

provinces in Oaxaca, so that the occurrence of two different forms of the same group within the borders of that state should not be surprising .

Both *Gerrhonotus taeniatus* Wiegmann and *G. deppii* Wiegmann are distinguished from *G. fuscolabialis* by the possession of conspicuous lateral areas of light-tipped scales and a relatively weak development of the dorsal osteoderms. In addition, *taeniatus* seems to have a slightly greater number of scales between the occipital and the posterior border of the thigh. *G. deppii* is also characterized by a number of other features, among the more important of which are the lack of a greenish or bluish color, the fact that only one anterior temporal enters the orbit, and the slight extent of the subgranular area on the side of the neck.

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The Eggs of Certain Plethodontid Salamanders Obtained by Pituitary Gland Implantation

By Robert B. Barden and L. James Kezer [1]

EGGS of *Typhlotriton spelaeus* Stejneger, *Eurycea lucifuga* Rafinesque, and *Eurycea neotenes* Bishop were obtained in the laboratory following implantation of fresh adult amphibian pituitary glands beneath the tongue musculature, as described by G. K. Noble and L. B. Richards (1930, 1932). The eggs were kept until they had had ample time to undergo cleavage, then were preserved in 10% formalin. Most of the descriptive data to be presented were obtained from this preserved material. The eggs of none of these species have been described hitherto, as far as the authors are aware.

The eggs of *Eurycea lucifuga* were obtained from a female selected from a collection made by L. James Kezer in the fall of 1941 at Robber's Cave, Stone County, Missouri. One whole pituitary gland from a *Rana pipiens* donor was implanted as mentioned above; afterwards the female was placed in a large, covered glass dish containing several flat rocks with enough water to cover most of them. The dish was kept at a temperature of 15–18° C. A few eggs were found on the evening of the second day, and within the next twenty hours a total of fifty-one eggs had been deposited singly in the water, scattered about over the bottom of the dish. None of them seemed to be attached, and it is possible that the eggs were not deposited in the manner typical of the species in nature. The eggs did not cleave and presumably were not fertile. All of them are unpigmented. They are closely surrounded by the vitelline membrane, about which there is a wide layer of fluid bounded by a more or less spherical, peripheral layer of clear jelly. The surface of the latter is a tough, elastic membrane that forms the covering for the entire egg. There are, then, two envelopes in addition to the vitelline membrane, the first (inner) envelope consisting of the layer of fluid, the second (outer) en-

[1] The authors wish to acknowledge the helpful suggestions of Professor A. H. Wright.

velope consisting of the peripheral layer of jelly. There is no third envelope, which is present about the eggs of the other two species as an outermost layer of jelly; the absence of such a layer may account for the fact that all of the eggs were found unattached. Although it is questionable whether the layer of fluid should be described as an envelope, it is designated as such in the eggs of all three of the species discussed in this paper because of the possibility that actually it may be homologous to the layer of jelly immediately surrounding the vitelline membrane of the eggs of some other amphibians, differing from this jelly layer of the latter only in consistency. A diagram of the egg and its envelopes is shown in Plate I, a photograph in Plate II, Figure 5. The diameters of several eggs and their envelopes are tabulated below.

TABLE I

AVERAGE DIAMETERS OF EGGS AND ENVELOPES IN MM., AFTER PRESERVATION IN 10% FORMALIN

Species	No. of eggs measured	Vitellus		Inner envelope	Middle envelope	Outer envelope
Eurycea lucifuga	7	Ave.	2.53	2.97	———	3.63**
		Max.	2.61	3.30	———	3.75
		Min.	2.41	2.70	———	3.52
					(elliptical)	
Typhlotriton spelaeus	7	Ave.	*	2.57	3.75 x 4.05	*
		Max.	2.01	2.70	3.90 x 4.50	9.00(?)
		Min.	2.21	2.47	3.22 x 3.82	7.00(?)
Eurycea neotenes	4	Ave.	1.70	1.83	3.73	4.05
		Max.	1.77	1.87	3.97	4.27
		Min.	1.64	1.81	3.52	3.75

* In order to preserve the eggs of *Typhlotriton*, they were scraped from the rock on which they were deposited, thus damaging the outermost jelly envelope. By the time this was done, moreover, the eggs were already somewhat degenerate and misshapen. Accordingly, measurements of the vitellus, and of the outermost jelly envelope are only approximate.

** The outer envelope of the eggs of *E. lucifuga* is probably homologous to the middle envelope of the eggs of the other two species.

The eggs of *Typhlotriton spelaeus* were obtained from one of three adult females collected, along with other specimens, by the authors in River Cave, near Camdenton, Camden County, Missouri, in the spring of 1942. A number of eggs were quite evident through the ventral abdominal wall of each of these three females. Two whole pituitary glands from *Desmognathus fuscus* donors were implanted in each one, which was then placed individually in a glass dish with conditions such as those described above for the *E. lucifuga* female. Two of the females failed to ovulate, although one was given two subsequent implants of an anterior lobe from a *Rana pipiens* donor, and the other was given three such implants, over a period of fifteen days. The third female, however, laid a total of thirteen eggs. Four were deposited, singly, seven days after the original implantation, and four days after the additional implantation of an anterior lobe from a *Rana pipiens* donor. Eleven days after the first ovulation, and after the implantation of two more anterior lobes from *Rana pipiens* donors, this female laid nine more eggs. Unlike the first four, which were found unattached in the water, all nine later eggs were attached to the moist surface of the rock just above the level of the water (see Pl. II, Fig. 6), and were deposited singly, although a few were laid side

FIGURE 1. Eurycea lucifuga

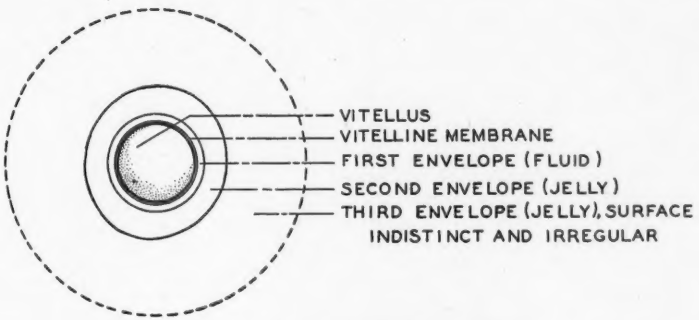

Figure 2. Typhlotriton spelaeus

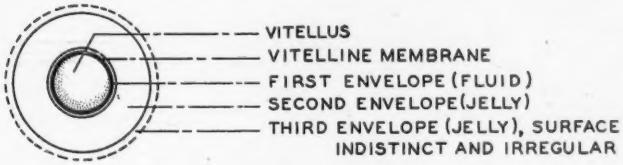

Figure 3. Eurycea neotenes

Figure 4. E. lucifuga T. spelaeus E. neotenes

COMPARISON OF VITELLUS SIZE

PLATE I

Diagrams of the vitellus and its envelopes drawn at five times natural size.

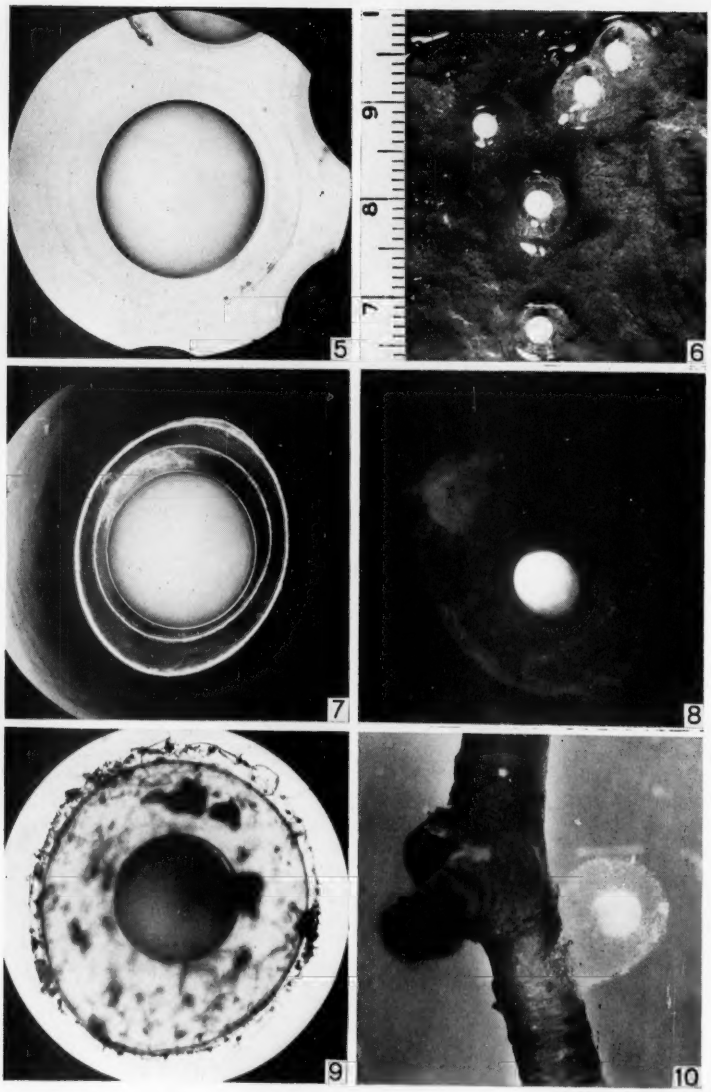

PLATE II

by side. The fact that all nine eggs were deposited in this way, despite the disturbance of the female several times during ovulation, may indicate that the eggs are deposited similarly on the damp rocks of the natural cave habitat. The eggs failed to cleave and presumably were not fertile. All are unpigmented. They are closely surrounded by the vitelline membrane, about which there are three envelopes. The first (inner) envelope consists of a wide layer of fluid, the second (middle) envelope consists of a wide layer of clear jelly, the peripheral margin of which tends to be elliptical, the third (outer) envelope, which is again roughly spherical (although very irregularly and indistinctly outlined), is another, very thick layer of jelly by which the eggs were attached to the moist rock. A diagram of the egg and its envelopes are shown in Plate I, Figure 2, photographs in Plate II, Figures 7–8. The diameters of several eggs and their envelopes are listed in the table.

The eggs of *Eurycea neotenes* were obtained from a female collected along with other specimens in January, 1942, by Professor and Mrs. A. H. Wright, and R. and E. S. Quillen at Cherry Springs, West Fork of Cibola Creek, near Bracken, Bexar County, Texas. Three implantations, each of an anterior lobe from a *Rana pipiens* donor, were made at two-day intervals, the female being kept in a glass dish under conditions similar to those in the above experiments, except that small glass jar covers were used instead of rocks. Two days after the third implantation, two single eggs were found unattached in the water. Twelve hours later, one of these had cleaved once, and in the following thirty-six hours it continued to cleave until the sixteen-cell stage was reached. The second egg failed to cleave. Two days after the first two eggs were deposited, a third was found. It cleaved once. Whether any of these eggs was fertilized is questionable. Eighteen days after the first ovulation, two whole pituitary glands of *Desmognathus fuscus* were implanted. Eight days later, nine additional eggs were found, laid singly and for the most part widely separated. Four of them were attached to twigs which had been placed in the water, two were attached to the glass jar covers, the remainder were unattached. None of these eggs cleaved. All are unpigmented. They are closely surrounded by the vitelline membrane, about which there are three envelopes, all more or less spherical. The first (inner) envelope consists of a

PLATE II

Fig. 5. Egg of *Eurycea lucifuga*, x 12. The two envelopes can be seen distinctly.

Fig. 6. Eggs of *Typhlotriton spelaeus* attached to the moist upper surface of a rock, x 2.2. Two of the eggs are deposited together, the rest singly.

Fig. 7. Egg of *Typhlotriton spelaeus*, photographed chiefly with reflected light, x 12. The boundaries of the first (inner) and second (middle) envelopes are prominent.

Fig. 8. Egg of *Typhlotriton spelaeus*, photographed chiefly with reflected light, x 5.5. This egg has been removed from the rock to which it had been attached; consequently the third (outer) envelope is torn and somewhat misshapen. The slightly elliptical boundary between the second (middle) and the third (outer) envelopes also can be seen. Notice the great thickness of the latter.

Fig. 9. Egg of *Eurycea neotenes*, x 12. The thinness of the first (inner) and third (outer) envelopes, as well as the great thickness of the second (middle) envelope is clearly shown.

Fig. 10. Egg of *Eurycea neotenes*, attached to twig, x 5.5. Although not shown in the photograph, only the third (outer) envelope is drawn out to form the attachment stalk.

very thin layer of fluid, the second (middle) envelope consists of a wide layer of jelly (containing numerous whitish granulations, quite possibly artifacts), the third and outermost envelope of another, thin layer of jelly. It is the thin outermost layer by which the eggs were attached to the twigs and to the glass jar covers. A diagram of an unattached egg with its envelopes is shown in Plate I, Figure 3; photographs of an unattached egg and of one attached to a twig are shown in Plate II, Figures 9–10. The diameters of several eggs and their envelopes are listed in the table.

Summary

The eggs of all three species, obtained by induced ovulation, were deposited singly. All are unpigmented, varying from white to pale yellowish-white in color. Most of them failed to cleave and were probably unfertilized.

The vitellus in the egg of *Euryces neotenes* is the smallest of the three species (1.64–1.77 mm. in diameter); that of *Eurycea lucifuga* is the largest (2.41–2.61 mm. in diameter); and that of *Typhlotriton spelaeus* is roughly intermediate in size (2.02–2.21 mm. in diameter).

In all three species the vitelline membrane, which closely invests the vitellus, is immediately surrounded by a layer of fluid which, in turn, is enclosed within one or two layers of jelly. In addition to the vitelline membrane, therefore, the vitellus is enclosed within several envelopes, of which the first and innermost is the layer of fluid. For each species these envelopes are as follows:

(a) The eggs of *Eurycea lucifuga* have two more or less spherical envelopes. The first (inner) consists of a layer of fluid, the second, (outer) of a wide layer of clear jelly. The latter is bounded by a tough elastic membrane. Unlike the eggs of the other two species, a third and outermost layer, also of jelly, is absent.

(b) The eggs of *Typhlotriton spelaeus*, on the other hand, have three envelopes. The first (inner) envelope consists of a wide layer of fluid, the second (middle) envelope consists of a wide layer of jelly, the peripheral margin of which tends to be elliptical, the third (outermost) envelope consists of another, very thick layer of jelly, irregularly and indistinctly outlined, but roughly spherical. It is this third envelope by which the eggs were attached to the surface of the moist rock.

(c) The eggs of *Eurycea neotenes*, like those of *Typhlotriton*, have three envelopes. All three tend to be spherical. The first and innermost is a layer of fluid, the second (middle) envelope is a wide layer of jelly. The third (outer) envelope is a very thin layer of jelly, in contrast to the very thick outermost layer of jelly in the eggs of *Typhlotriton;* like this outermost layer of the latter, it is irregularly outlined.

Literature Cited

Noble, G. K. and L. B. Richards

1930 The induction of egg-laying in the salamander, *Eurycea bislineata*, by pituitary transplants. *Amer. Mus. Novitates*, 396: 1–3.

1932 Experiments on the egg-laying of salamanders. *Ibid.*, 513: 1–25, fig. 1–7.

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Herpetological Notes

SOME INSECT FOOD OF *RANA PIPIENS*.—Since 1931, 91 specimens of *Rana pipiens* Schreber have been collected in various localities in Utah, and 6 additional specimens from Fish Haven, Preston and Riverdale in southern Idaho. An examination of the stomach contents of the 97 specimens revealed that they had recently eaten: 91 Orthoptera (in 58 of the stomachs), 4 nymphal and 82 adult short-horned grasshoppers, 3 long-horned grasshoppers, and 2 field crickets; 1 may-fly naiad; 8 Odonata, 5 naiads and 3 mature damsel flies; 1 stone-fly adult; 43 Hemiptera included the injurious *Lygus elisus, L. hesperus,* the false chinch bugs, 6 pentatomid bugs, besides 18 water-striders, 1 backswimmer and 5 shore bugs (Saldidae); 13 Homoptera included 7 adult and 1 nymphal leafhopper; 1 of 5 aphids present was a pea aphid and another an English grain aphid. The Coleoptera (124) included such injurious forms as 13 adult click-beetles, 1 leaf beetle, and 2 scarabaeids; one of 4 weevils was an alfalfa weevil; while beneficial or non-injurious forms included 37 ground beetles, 10 ladybird beetles (one a *Hippodamia convergens* and two 13-spotted ladybirds), 3 silphids, 1 dermestid, 2 hydrophilids, and 12 adult and 15 larval dytiscids. Three adult Trichoptera were found; 42 Lepidoptera, 2 of which were adults, the rest being larvae, of which 6 were sugar-beet webworms, at least 10 cutworms and 1 zebra caterpillar; 53 Diptera included 1 housefly, 2 blowflies, 14 adult mosquitoes, approximately 500 mosquito eggs in one stomach, 3 midges, 2 Dolichopodidae and 1 deer fly, *Chrysops discalis;* 28 Hymenoptera included 7 ants, 1 vespid, 4 sphecid and 1 chrysidid wasp, 1 honey bee, 1 halictid bee and 1 ichneumonid-fly. Seventy-four spiders were recognized in 41 of the stomachs; there were 3 sow bugs; and 30 snails in 16 stomachs. Five stomachs contained plant material, probably ingested while capturing animal prey. In addition, 6 stomachs held recently shed frog-skin. One full-grown frog collected in the fields west of Logan, Utah, September 11, 1934, had a small frog of the same species in its stomach.—G. F. KNOWLTON, *Utah Agricultural Experiment Station, Logan, Utah.*

SIZE OF THE SALAMANDER *BATRACHOSEPS MAJOR*.—A live specimen of *Batrachoseps major* Camp, received from near the type locality, was so large that I became interested in the size range for this species. All available specimens were checked for the maximum length in various collections. As far as I have been able to ascertain to date this specimen (No. 1077, San Francisco State College) is by far the largest one of this species known.

The Stanford University collection contained only small individuals and hence measurements were not taken of them. The same proved true of the collection at the California Academy of Sciences. The University of California at Los Angeles reported that they did not have specimens of this species.

The following list gives the measurements for large specimens in various collections as noted. All specimens were collected within a small area in southern California.

COLLECTION	NUMBER	TOTAL LENGTH	TAIL LENGTH	LOCALITY
SFSC	1077	177.0 mm.	114.0 mm.	Claremont, Los Angeles Co.
Klauber	9536	156.0	103.0	San Clemente, Orange Co.
Mus. Vert. Zool.,	4585	155.0	94.0	Pasadena, Los Angeles Co.
Univ. Calif.	611 (type)	134.4	79.5	Sierra Madre, "
Los Angeles	1	108.5	62.0	Pasadena, "
City College	2	114.5	68.5	Pasadena, "
	3	98.0	51.0	Pasadena, "
	4	117.0	68.0	Pasadena, "
	5	104.0	60.0	Pasadena, "
	6	98.0	51.0	Pasadena, "

It can be seen from the above list that the Claremont specimen (No. 1077) is 21.0 mm. longer than the largest specimen found in any of the collections reported. It was taken on April 5, 1941, at an altitude of 1250 feet, along Thompson Creek, Claremont, Los Angeles Co., California.—EDNA M. FISHER, *2410 Fulton St., Berkeley, California.*

STATUS OF THE RIDLEY TURTLE IN MASSACHUSETTS WATERS.—A Massachusetts specimen of *Lepidochelys kempii,* discovered in the collections of the Peabody Museum of Salem, and reidentification of Massachusetts specimens of sea turtles catalogued either as ridley or loggerhead turtles in the Boston Society of Natural History and the Museum of Comparative Zoology, indicates that a review of the occurrence and comparative status of these two species in Massachusetts waters on the basis of known specimens is desirable.

For many years it has been assumed that the loggerhead turtle is a not uncommon and comparatively regular visitor to the waters of our state, while the ridley turtle (also variously known as the bastard, Kemp's and Gulf turtle) is of such rarity as to be only accidental (Stejneger and Barbour, Check List, 1939: 170). It was apparently on this basis that Babcock (1919, Mem. Boston Soc. Nat. Hist., 8: 346) included the loggerhead but specifically excluded the ridley (*ibid.*: 327).

Enough evidence had evidently accumulated by 1938 to warrant Babcock's inclusion of the ridley as well as the loggerhead in the *Field Guide to New England Turtles.* A specimen taken off Swampscott was then recorded. In 1942 a paper by Carr noted another Massachusetts specimen, found dead at No-Man's-Land in 1903, in the Boston Society of Natural History (1942, Proc. N. E. Zool. Club, 21: 11). Barbour subsequently published a record of a young ridley from Boston Harbor and a fuller account of the No-Man's-Land specimen (COPEIA, 1942: 257). This concludes the published record.

The story continues with the Salem specimen. In the course of reorganizing the Natural History collections of the Peabody Museum of Salem, a number of important and heretofore unnoticed specimens came to light, not the least interesting of which was a well mounted example of the ridley turtle. Our specimen, identified by Dr. Thomas Barbour, was taken off Rockport in 1910 and given to the Museum by General William Stopford of Beverly in the same year. Since its accession this turtle has been in the Essex County collections of the Peabody Museum, labeled as a loggerhead.

As this was not only the fifth record for Massachusetts but also the northernmost known, Dr. Barbour suggested that I write a note on it. On going to the Boston Museum to examine the ridleys known to be there, a third ridley was discovered in the storage collection, labeled only "Atlantic Ocean" and with no other data. These specimens of course may or may not be from off our shores. After overhauling the storage collections I went to look at the turtle on exhibition which was labeled as a loggerhead, and which had been taken at Wood's Hole at an unknown date. This specimen also appeared to be a ridley. Dr. Babcock agreed with my conclusion. Thus it appears that the Boston Society has four ridleys, three of them definitely from Massachusetts waters, with not a single example of the loggerhead. I then hurried over to Cambridge and found that the Museum there has one supposed "loggerhead" on exhibition, from Massachusetts Bay. To my surprise I was forced to conclude that this beast, too, was a ridley. The next day I called Dr. Barbour's attention to the specimen and he agreed at once to my identification. This brings the number of Massachusetts ridleys to seven with a possible eighth. In the order of their recognition they are:

1. BS 1215 Taken off Swampscott, Oct. 10–20, 1905. Coll. by Dr. S. J. Mixter. Donor, Dr. Thomas Barbour, Dec. 22, 1920. Carapace 11″ long, 11″ wide. (Babcock, Field Guide: 46.)
2. USNM 55,734 Mass. Locality unknown. Coll. Aug. 21, 1907. (Carr: 11.)
3. BS 1215 No-Man's-Land, 30 miles south of Gay Head, Martha's Vineyard, March, 1903. Carapace 12″ long. (Carr: 11; Barbour: 257.)
4. MCZ 46537 Boston Harbor, 1942. Carapace 9.5″ long, 9″ wide. (Barbour: 257–8.)
5. PM No no. Off Rockport, 1910. Carapace 20.5″ long, 18.5″ wide.
6. BS Orig. 1002 Atlantic Ocean. Carapace 15.5″ long, 16″ wide.
7. BS 1090 Woods Hole, coll. at Marine Biol. Laboratory. No date. Carapace 20″ long, 18″ wide.
8. MCZ 1405 Massachusetts Bay.

As each of the ridley specimens has been recognized it has so far decreased the number of loggerhead records. The three finest exhibition specimens, one each at the Peabody

Museum, the Boston Society of Natural History (1090), and the Museum of Comparative Zoology (1405), are apparently ridleys and not loggerheads as they have been mislabeled for all these years. Conversely no complete specimen of a loggerhead from Massachusetts now exists in any of the three institutions, although there may be some skulls.

It appears that on the basis of known specimens the ridley is by far the commoner of the two turtles in Massachusetts waters and the status of the two species is exactly the opposite of what has been commonly supposed. Needless to say the problem should not be left as it now stands. The fish wharves should be systematically combed and the identity of all turtles brought in should be carefully recorded, further to clarify the question as to the occurrence of these two turtles in northern waters.—ERNEST S. DODGE, *Peabody Museum of Salem, Salem, Massachusetts.*

PATTERN AND COLOR VARIATION IN CANAL ZONE SALIENTIA.—The specimens on which this study was made were collected[1] on Barro Colorado Island, C. Z., between December 25, 1940 and January 21, 1941. Striking variations in color pattern in *Engystomops pustulosus, Bufo typhonius* and *Eleutherodactylus fitzingeri,* and the coloration in life of various other forms were noted.

In five of seven specimens of *Engystomops pustulosus* the dorsal part of the head and trunk are uniform dark brown with the exception of a very small white spot in the interscapular area in three specimens and two more lateral small light spots in one. All five have a diamond-shaped interscapular area outlined by tubercles. In two additional specimens (one male and one female) the diamond-shaped area is lacking and the back bears a medial light tan stripe, extending from the coccyx to the anterior level of the eye, becoming broader on the head, where it is penetrated by two narrow dark stripes. Lateral to the median light stripe on each side of the trunk is a dark brown triangular area. Lateral to this is a broad, dorso-lateral, light tan area extending from the level of the posterior limb to just posterior to the eye. Adjacent to this, in a latero-ventral position, is a dark brown stripe. Despite the very different dorsal and lateral patterns the ventral surface is marked like the other specimens of this species.

Two of five specimens of *Bufo typhonius* are dorsally almost uniform tan (of a greenish cast), with reddish warts, and one has a narrow, light, medio-dorsal line. Three other specimens have a dark brown irregular pattern on either side of a median light streak, almost white in two (one male and one female) and a less well defined tan streak in one (male). The dark pattern extends continuously in the former two specimens from the sacrum to the interocular region. In the specimen with a tan line the pattern has several interruptions.

Of sixteen specimens of *Eleutherodactylus fitzingeri* all but two have brown head and trunk dorsally, with some darker brown and black markings which do not form a pronounced pattern. In life there are green and red tones on most specimens. Two exceptional individuals (one female and one male) have a dorso-medial light tan stripe extending from snout to coccyx, broader anteriorly, and bordered laterally by a narrow discontinuous (dashed) dark brown stripe. Prof. E. R. Dunn writes me that in his specimens of *E. fitzingeri* from Barro Colorado Island the mid-dorsal stripe is usually associated with the male sex. He finds the stripe on some males but never on females. It is of interest, therefore, that one of the specimens with a mid-dorsal stripe in my collection is a female with well-developed ovaries and convoluted Mülerian ducts. The gonads of many of the other specimens are small. To eliminate doubt as to the sex, the entire right gonad and part of the mesonephros and fat body of each unusual specimen of the three genera discussed were serially sectioned and stained. None of the variant patterns is limited to one sex.

Four of five specimens of *Eleutherodactylus ockendeni* had a distinct pink cast when alive. Dunn (1931, Occ. Pap. Boston Soc. Nat. Hist., 5: 418) describes this species as "nearly uniform light gray above," which is the color of our specimens after preservation in weak formalin.

One of three specimens of *Hyla sordida* had bright green spots dorsally on head and trunk, a coloration not mentioned by Günther (1901, Biol. Centr. Amer., Reptilia and Batrachia, Pt. 35: 273) for this species. All three had purplish-blue dots on the otherwise

[1] I wish to thank Prof. E. R. Dunn of Haverford College for permitting me to read his manuscript concerning Barro Colorado Island, containing helpful suggestions on methods of collecting and preserving amphibians.

brown posterior part of the thigh and one had them also on the anteroventral part of the thigh, medial part of the leg and lower lateral region of the abdominal wall. None of these colors remains in the preserved specimens.

One specimen of *Hyla phaeota* was taken. Before preservation it had a beautiful green band below the eyes and below the characteristic dark band; this is not mentioned by Günther (*op. cit.*)—RUTH S. COOPER, *Dept. of Biology, Princeton University, Princeton, New Jersey.*

FEEDING HABITS OF A CENTRAL AMERICAN OPISTHOGLYPH SNAKE.—Some years ago I obtained and kept for a period of several weeks a fine example of the snake-eating Central American opisthoglyph snake, *Conophis lineatus* ssp., or "Guardo del Camino" (road guarder). When received, the snake was in excellent condition, quite sleek and glossy. It soon acclimated itself to the 3-foot cage supplied with sandy loam in which it was kept. Although provided with some slabs of bark under which it might seek cover, the snake preferred to root about constantly, and systematically investigated every possible nook and cranny of its cage. This activity was maintained as long as it remained under observation.

The *Conophis* measured 23 inches from snout to tip of tail, and shortly after its receipt, an 18-inch *Thamnophis s. sirtalis* was introduced into its cage. The garter snake was seized by the nape of its neck with the utmost celerity, the bite resulting in profuse bleeding. Subsequently, it was released, and then bitten again, this time near the middle of the body. Eight minutes after the initial attack, it showed very little life, either from the loss of blood or due to the effect of the *Conophis* venom. Swallowing, beginning with the head, commenced in a few minutes. Thirty-six minutes after it was first bitten, the garter snake had been completely swallowed. The process was characterized by certain specific actions. The garter snake was swelled with air, which made engulfment difficult; when it had been about one-third swallowed, the *Conophis* arched the forward third of its body, with the head pointing downward, and utilized a combination of a chewing, lateral jaw action, and a very noticeable series of peristaltic contractions. A peculiar action noted immediately before and after feeding was the lateral and vertical waving of the anterior 3 or 4 inches of the body. There was no constriction, nor was there any attempt to hinder the thrashing of the prey, as pictured by Ditmars (Snakes of the World, 1937: pl. 27, upper).

Three days later, simply to learn if the despatch with which the *Thamnophis* had been eaten was a matter of hunger, or characteristic of the usual mode of feeding, another *Thamnophis,* 20 inches long and somewhat distended with food, was put into the *Conophis* cage. Although the *Conophis* was still clearly distended with the first garter snake, this second *Thamnophis* was attacked with the same celerity, but slightly different results.

From the time of introduction until the garter snake completely disappeared occupied one hour and twenty minutes, in which period, the *Conophis* attempted to swallow, and then disgorged, fifteen times! When engulfment was finally completed, the *Conophis* was enormously distended, and much too taut to coil properly. The entire action was characterized by deliberation; the garter snake was chased around the cage until it was trapped behind the water pan. The same lateral and vertical swaying was noted, and the same conspicuous use of the fangs.

Nine days later the *Conophis* was tempted with a medium-sized *Storeria dekayi,* which it promptly swallowed. In the month following, it was fed a varied assortment of young toads, hylas, and two more *Storeria.* In no instance was the prospective meal refused.—M. B. MITTLEMAN, *470 Pelham Rd., New Rochelle, New York.*

LIFE SPAN OF THE SPADEFOOT TOAD.—In view of the dearth of data on the longevity of common amphibians, it seems advisable to record the age attained by a pet spadefoot toad (*Scaphiopus holbrooki holbrooki*) cared for by my mother, Mrs. Grace Petrides, at Washington, D.C. Captured as an adult in eastern North Carolina in March 1937, it lived in a bowl of earth in a single burrow just deep enough to cover it until April, 1942, when it died, apparently of old age. Though inactive for short periods during the winter months, it usually consumed 6 to 10 mealworms per week during life. It was at least six years old at the time of its death. Flower (1925, Proc. Zool. Soc.

London: 280) records the known life of this species in captivity as six months.—GEORGE A. PETRIDES, *National Park Service, Washington, D.C.*

NORTHWARD OCCURRENCE OF THE SPOTTED TOAD AND THE NORTHERN CRESTED LIZARD IN CALIFORNIA.—During recent investigations for fish life in the desert region of eastern California, reptiles and amphibians were observed and collected by the writer in the isolated basin of Saline Valley. This valley lies in west-central Inyo County, California, directly northeast of Owens Lake (see U. S. G. S. Ballarat Quadrangle). It is separated from Owens Valley on the west by the rugged Inyo Mountains, from Death Valley on the east by the northern end of the Panamint Mountains, and from both Eureka Valley on the north and Panamint Valley on the southeast by high, arid divides.

The spotted or canyon toad, *Bufo punctatus* Baird and Girard, was found at two localities in Saline Valley in 1937 and 1939. Young to adult were common at Hunter Creek, on the west side of the valley, on May 28–29, 1937, and May 28, 1939. In 1939, 3 newly metamorphosed young (MVZ, Nos. 31479–81) were collected from hiding places along the creek. The elevation where the toads were taken is about 2,000 feet, well above the large playa on the floor of the valley. Further specimens were collected from Willow Creek. This stream enters the valley from the northwest and runs through a marshy area thickly matted with vegetation. Adults of the species appeared in great numbers in the evening on May 30, 1937, and May 28 and 29, 1939. In the latter year 46 half-grown to adult specimens (MVZ, Nos. 31486–31531) were collected along the bluffs bordering the creek, 64 tadpoles (MVZ, No. 31838) were taken from the stream, and many more toads were seen. The elevation near the mouth of Willow Creek is about 2,200 feet. It is believed that these localities represent a northward extension of the known range of this species in California.

The northern crested lizard or desert iguana, *Dipsosaurus dorsalis dorsalis* Baird and Girard, was also collected in Saline Valley in 1937 and 1939. On May 29, 1937, a large, gravid female was caught along a sandy wash near the Upper Warm Spring on the northeastern side of the valley. The air temperature at the time of capture (about 10:30 A.M.) was nearly 90° F. An adult (MVZ, No. 31626) was shot on a mesquite-dune habitat, about 5 miles north of the old salt works at the western edge of the salt lake, and 5 young to adult (MVZ, Nos. 31627–31631) were similarly secured near Willow Creek, from alluvial slopes dotted with creosote bush (May 27–28, 1939).

Saline Valley was not thoroughly searched for either *Bufo punctatus* or *Dipsosaurus dorsalis* during my two brief visits. I am grateful to Thomas L. Rodgers of the Museum of Vertebrate Zoology (MVZ), University of California, who kindly allowed me to record the unpublished data in his care.—ROBERT R. MILLER, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

Ichthyological Notes

REGANULA GIGANTEA TO REPLACE *REGANICHTHYS GIGANTEUS*.—Doctor Leonard P. Schultz has called to our attention the fact that the name *Reganichthys*, given to the giant Ceratioid fish described by us (Proc. New Engl. Zool. Club, 23, April 14, 1944: 9–15, pls. 4–6) as a new genus and species, is preoccupied, having appeared (Memoirs Queensland Museum, 3, 1915: 123) as a generic name for Ogilby's new fish, *Reganichthys magnificus*. We would, therefore, rename this genus *Reganula*. The species would then be *Reganula gigantea* Bigelow and Barbour.—HENRY B. BIGELOW and THOMAS BARBOUR, *Museum of Comparative Zoology, Cambridge, Massachusetts.*

ON THE YOUNG OF *CARANX VINCTUS* JORDAN AND GILBERT.—The characters of the young of different species of *Caranx,* correlated with their life and habitat, are of much interest to the writer. Through the courtesy of Mr. Loren P. Woods (now in service) and the Chicago Natural History Museum, he has examined five young *Caranx vinctus,* taken by Mr. Woods 120 and 125 miles southwest of Cape Mala, Panama, February 25, 1941. According to the field notes four were taken in a dip-net from under a log, as were also small *Psenes* of comparable size, to which they bear a superficial resemblance, on account of both having rather pale bodies and dark vertical and ventral fins.

The five, which measure 27, 32, 37, 41, 54 mm. standard lengths, are not unlike the young of *Caranx crysos,* with the arch of the lateral line notably higher, the same being steeper and more S-shaped behind; in the larger the scaly sheathes of vertical fins are already more appreciable; and the color is different. Appreciably developed scutes are confined to the posterior part of the straight part of the lateral line.

Four of from 32 to 54 (average 41) mm. show little age change in depth, 2.9 to 3 in length (average 2.95); eye, 3.4 to 3.6 in head (3.5); chord of the arch, in straight part of lateral line, 1.6 to 2 (1.77½). Similarly the three of 37 to 54 (average 44) mm. have head 3.2 to 3.3 in length (average 3.27); pectoral in head, 1.4; appreciable scutes 32 to 34 (33.3).

We have a smaller specimen, 17 mm. standard length, provisionally referred to and now confirmed as of this species of *Caranx,* which was taken by Templeton Crocker outside Topolobampo Bay, Mexico (25° 30′ N., 109° 12′ W.), Nov. 17, 1935. Its head is 2.4, that of the 27 mm. specimen, 2.7, of the 32 mm., 2.9; pectoral is 1.7½, that of the 27 and 32 mm. specimens, 1.6; eye is 3, as in the 27 mm. specimen; curve in straight part of lateral line, 1.5, 1.5 to 1.6 in the 27 mm. specimen. There are only 23 to 26 scutes appreciable in these three of 17 to 32 mm.

As to color, the body is pale, likely faded (darker, smoky in that of 17 mm.), somewhat darker dorsally, whitest below in the largest. The three from 32 to 41 mm. have appreciable fine punctulations, especially on the lower half, among which there are scattered larger blackish specks. Faint, dark cross-bands, wider than the interspaces, appreciable in the five from 17 to 41 mm., about 8 in the three largest, 7 in that of 27 mm., 6 in that of 17 mm., which has a whitish peduncle and additional dusky cross-blotch at the base of the caudal. Spinous dorsal blackish, with a narrow pale margin in that of 17 and that of 27 mm. Short spinous anal blackish, only dusky in that of 17 mm. Soft dorsal and anal dusky, less completely so in that of 32 mm., only basally dusky in that of 27 mm., colorless with dark marks along their bases in that of 17 mm. Ventrals blackish or dusky, more or less paler at their lateral margins. Caudal and pectorals colorless.—J. T. NICHOLS, *American Museum of Natural History, New York.*

ALBINO CATFISH IN VIRGINIA.—The fishery for the channel cat and allied species constitutes a small but locally important commercial enterprise in the fresher waters of the east coast of Virginia (Contrib. No. 18 of Va. Fish. Lab., Trans. of Am. Fish. Soc.—in press). However, the albino channel catfish has seldom been taken and then only from the Pamunkey and Mattaponi rivers which converge at West Point to form the York River.

In the fall of 1940 an albino channel catfish, *Ictalurus punctatus,* was brought to the laboratory as a curiosity. It had been caught in the Mattaponi River by Mr. J. C. Smith of Holdcroft, Virginia, who stated that he had caught several before. During the last two years, Mr. Waldner Sulik, fishing for catfish in the Pamunkey River, has caught several hundred of these albinos along with fish of the same species having the normal color; and 22 specimens have been brought to the laboratory. Several maintained in an aquarium were alive and healthy at the end of six months.

These fish appear to be true albinos, having whitish cream colored skin and pink eyes. Most of the individuals range from 10 to 12 inches in length. One specimen is a little over 17 inches long, and weighs nearly 2 pounds.—R. WINSTON MENZEL, *Virginia Fisheries Laboratory, Yorktown, Virginia.*

CORYPHAENOIDES BARATTINII FOWLER, 1943, SYNONYM OF *COELORHYNCHUS MARINII* HUBBS, 1934: A MACROUROID FISH OF THE SOUTH ATLANTIC.—A species of the deep-sea fish family Coryphaenoididae, inhabiting the South Atlantic off the coast of southern South America, has been given two specific names. It was first described as *Coelorhynchus marinii* Hubbs (Occ. Pap. Mus. Zool., Univ. Mich., 298, 1934: 1–9, pl. 1). Very recently what is obviously the same species has been renamed *Coryphaenoides barattinii* Fowler (Proc. Acad. Nat. Sci. Phila, 95, 1943: 323–325, figs. 16–17).

The allocation of this species in two genera is not very surprising, for it is one of the least modified—most *Coryphaenoides*-like—of the forms referred to *Coelorhynchus*. A consideration of the known characters, however, seems to justify its reference to *Coelorhynchus*. Outstanding among the features which seem to align the species with *Coelorhynchus* are the nondenticulate dorsal spine and the bold, continuous head ridges, armed with strong and especially spiny scales.

A comparison of the type description and figure of *Coryphaenoides barattinii* with the types of *Coelorhynchus marinii* discloses many points of correspondence and no significant differences. The major discrepancies are largely attributable to errors in the description of *C. barattinii*. Thus a wide difference in the number of scales below the lateral line is obviously due to the misplacement of the lateral line in the type description and figure of *C. barattinii:* in the single type specimen, almost wholly devoid of scales, the axial septum of the body wall muscles was certainly mistaken for the lateral line, which anteriorly is arched far above the septum to parallel the dorsal contour of the trunk. The dorsal spines are given as III in the description, in contradiction to the type figure and to the subfamily character (2 dorsal spines—the first very short; the second, long). The pelvic ray formula is given as I, 6 in *barattinii* and as 7 for *marinii*, but it is safe to assume that no real difference exists, because the lack of the pelvic spine is an ordinal character of the Anacanthini.

The body contours in the drawing of the type of *barattinii* do not converge as rapidly behind the vertical of maximum depth as they do in the types of *marinii*, but it seems wholly unlikely that a specific distinction is thus indicated.

The agreement between the two nominal species extends to such details as those of color. In the description of *marinii* no mention was made of the "contrasted black" of the pectoral origin and axil, described and drawn for *barattinii*, but I find that the loose, bare skin on the inner side and upper edge of the pectoral base is black in the holotype of *marinii*, as it generally is in the macrouroids.

Although many of the characters that frequently provide specific differentiae in the Coryphaenoididae are not described for *Coryphaenoides barattinii*, there seems to be no good reason to doubt the identity of this nominal species with *Coelorhynchus marinii*. The type localities are reasonably close: Lat. 35° 8′ S., Long. 52° 37′ W. for *barattinii*, and Lat. 38° 52′ S., Long. 56° 20′ W. for *marinii;* both well off the South American shore, respectively opposite and a little south of Mar del Plata. The species is widely distributed in the western subantarctic portion of the South Atlantic, for the paratype of *C. marinii* was collected near South Georgia Island.—CARL L. HUBBS, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

NOTES ON THE FOOD OF SMALLMOUTH BASS (*MICROPTERUS DOLOMIEU*) IN COLUMBIA LAKE, CONNECTICUT.—For several angling seasons, the writer has had an opportunity to examine the stomach contents of smallmouth bass (*Micropterus dolomieu*) taken in Columbia Lake, Tolland County, Connecticut. This note summarizes the food of 51 specimens taken during July, August, and early September of 1935, 1937, 1939, and 1943, and observations made since 1930. The 51 bass examined ranged from 10 to 17¼ inches in total length (average, 11.7 inches) and were taken by trolling or fly-casting. The data on the food in the stomach were of a cursory nature, and the procedure simply involved noting the relative size, kind, and number of food items in the stomach when the fish were cleaned.

Columbia Lake has an area of 282 acres, a maximum depth of about 26 feet and an average depth of about 17 feet (Appendix III, *in:* A Fishery Survey of Important Connecticut Lakes, Bull. No. 63, State Geol. and Nat. Hist. Surv., 1941). The shore

line is largely rocky with dense beds of *Nitella* carpeting the bottom in the neighborhood of the 5 to 10 foot contour. There are two prominent sand and gravel shoals arising in the deep water. Most of the bass examined came from the *Nitella* beds surrounding these shoals. The other species of fish present are: yellow perch (*Perca flavescens*), chain pickerel (*Esox niger*), bullhead (*Ameiurus n. nebulosus*), calico bass (*Pomoxis nigromaculatus*), bluegill sunfish (*Lepomis macrochirus*), red-bellied sunfish (*Lepomis auritus*), pumpkinseed (*Lepomis gibbosus*), common sucker (*Catostomus c. commersonnii*), golden shiner (*Notemigonus c. crysoleucas*), barred killifish (*Fundulus d. diaphanus*), and the fallfish (*Leucosomus corporalis*).

Of the 51 bass examined, 14 were empty (27 per cent). It is of interest that in 40 specimens taken prior to 1943, only 6 were empty (15 per cent), while in 11 bass stomachs examined in 1943, 7 were empty (64 per cent). These data incorporated into a contingency table and tested by Chi-square (see Patterson, D. D., 1939. Statistical technique in agricultural research. McGraw-Hill Book Co.: 77) indicate that the difference in ratio observed between empty stomachs and stomachs containing food is greater than would be expected by chance ($P = > 0.01$). Evidently some factor caused the bass taken in 1943 to have less food in their stomachs, at least by the time they had been boated. One explanation might be the fact that the 1943 bass were taken during a restricted period of a few days in late August and early September, whereas the other bass were taken throughout the season. Experience has shown that bass fishing is more apt to be of an uncertain quality during late summer, and this might in turn suggest less inclination on the part of the bass to feed.

The food of the remaining 37 specimens may be summarized as follows:

	Fish	Crayfish	Insects
Frequency of Occurrence	7	33	5
Number Individual Organisms	7	50	....

No attempt was made to estimate or measure the volume of the food eaten, but it was obvious that insects were negligible quantitatively, and that crayfish comprised the main staple of food. In this water, two species of crayfish are present: *Cambarus immunis* and *C. limosus*. The first species formerly occurred to the exclusion of *C. limosus*, which now appears to be the dominant form in the lake. Six of the 46 crayfish eaten were *C. immunis*. The crayfish eaten were usually of fair size (1½ to 3½ inches), the maximum number found in the stomach of any one individual being four (and in one of these the remains of at least six more could be identified in the intestinal contents).

The insect food in the specimens examined consisted of a dragonfly nymph and several flying ants (Hymenoptera). Over the period of years it has been consistently observed that smaller bass feed actively on the surface during early May when adults of the alderfly (*Sialis infumata*) are active on bushes overhanging the water. Later in the season (late June and sometimes early July) when the mayfly, *Hexagenia*, emerges, the larger bass sometimes feed on the subimagoes at the surface. Since the nymphs transform above the mud flats in the deeper water, this mayfly is not so available to the large numbers of small bass frequenting the rocky shallows at this time. Yellow perch of from 8 to 12 inches are the fish feeding most heavily on the surface when this mayfly emerges.

Of the 7 fish recorded from the stomachs of the bass examined, 3 were bullheads (about 3 inches long), 3 were yellow perch (1½ to 4 inches), and one was unidentifiable. Occasionally bass are taken which disgorge their stomach contents while being drawn to the boat, particularly in the case of bass which have been feeding on perch fingerlings.

The prospect of fish disgorging their food when captured by angling (or by other methods such as gill-netting), is further complicated by the probability that certain foods may be more easily disgorged than others, consequently conclusions based on the observed food may be biased. Westman (1941, A consideration of population life-history studies in their relation to the problems of fish management research, with special reference to the small-mouthed bass, *Micropterus dolomieu* Lacépède, the lake trout, *Cristivomer namaycush* (Walbaum), and the mud minnow, *Umbra limi* (Kirtland). Doctoral Dissertation, Cornell University Library) is of similar opinion based on observations of bass in Lake Simcoe, Ontario. The writer has observed several series of stomachs from gill-netted bullheads and yellow perch which were completely devoid of food, but in which the stomachs had been distended to capacity with water.—DWIGHT A. WEBSTER, *Laboratory of Limnology and Fisheries, Cornell University, Ithaca, New York.*

REVIEWS AND COMMENTS

NORTHERN FISHES WITH SPECIAL REFERENCE TO THE UPPER MISSISSIPPI VALLEY. By Samuel Eddy and Thaddeus Surber. University of Minnesota Press, Minneapolis, 1943: i-xi, 1–252, frontisp., figs. 1–57 (4 col.), diags. 1–3. $4.00.—This book was written as a Fishes of Minnesota and should have borne that title on the printed cover. It will prove interesting and valuable, however, to anglers, fishery workers, conservationists, and nature students throughout the north-central and northeastern states and the adjacent parts of Canada; and indispensable to all ichthyologists, from beginners to experienced specialists, who are studying the vast fish fauna of eastern North America.

The treatise begins with appealing essays on A Fisherman's Luck, Fish Production and Its Management, Lake Dynamics and Lake Improvement, Stream Improvement, and Improving the Quality and Conditions of Fish Populations. These well-written discussions will go far toward educating the interested public in modern methods of fish management and environmental control. The fishery worker, however, will miss details and documentation. To me the high-light in these introductory chapters is the proposal of a classification of lakes into types adapted to specified game fishes. The sections on the general structure and classification of fishes are brief and only moderately adequate.

The strictly up-to-date systematic nomenclature will prove to be one of the more useful features of *Northern Fishes*. The keys and brief descriptions will usually suffice for identification. To some ichthyologists the most valuable items will be the discussions of the status and distribution of the various species in Minnesota. Unfortunately the assigned range of certain species in the state has been extended too far to the northward, chiefly on the basis of Evermann and Latimer's records for the Lake of the Woods region. I have prepared for COPEIA a correction of these erroneous records, some of which have led to false ideas regarding the routes of Postglacial redispersal which the species are assumed to have followed.

For many species there are given brief remarks on ecology, habits, fecundity, propagation, etc. These notes are based to a large extent on original observations, which constitute an important addition to the knowledge of northern fresh-water fishes. The most significant contribution is probably the account of the "silver muskellunge," an unspotted mutant of *Esox lucius* which has become established in several Minnesota lakes.

This sport is beautifully illustrated in color along with a muskellunge. The three other colored plates are hardly up to modern standards. The numerous half-tones, however, very successfully bring out recognition features.

It is to be hoped that this attractive volume will run into new editions, for it deserves a wide sale, and numerous small errors should be corrected.—CARL L. HUBBS, *University of Michigan, Ann Arbor, Michigan.*

BOOKS RECEIVED

FISH REMAINS FROM THE MIDDLE DEVONIAN BONE BEDS OF THE CINCINNATI ARCH REGION. By John W. Wells. Paleontographica Americana, 3(16), 1944: 99–160, 9 text figs., Pl. 7–12.

EDITORIAL NOTES AND NEWS

Honor Roll

ADDITIONS to and changes in the list of members in the U. S. armed services are: PFC. WM. J. GRANT, Army Medical Corps; PVT. ROBERT L. HAAS, U.S. Army; SGT. ROBERT F. INGER, U.S. Army; PVT. HARRY L. ITSKOWITZ, Army Medical Corps; CAPT. JUSTIN W. LEONARD, Army Sanitary Corps; SGT. ROBERT LIVINGSTON, U.S. Army; ENS. GEORGE H. PENN, JR., U.S. Navy; LT. M. B. SCHAEFER, U.S. Navy; PVT. EDWIN H. SINCOCK, U.S. Army; CAPT. G. H. SOULEN, U.S. Army.

News Notes

THE following word has been received from DR. SUNDER LAL HORA, the accomplished Indian ichthyologist: "You must have learnt by now that the Zoology Section of the Indian Museum was shifted to Benares in April, 1942, and that I accepted the Directorship of the new Department of Fisheries in Bengal about the same time. I do not find any opportunity for taxonomic work now, but there is a lot to be done for the development of fisheries in this country." Dr. Hora's new address is 1, Deodar St., Ballygunge, Calcutta.

DR. W. C. SENNING, of the New York State Conservation Department, who has served for some years as district fisheries biologist at Rochester, has now moved to Albany to take over the duties of DR. EMMELINE MOORE, who retired in March.

CAPTAIN PHILIP J. DARLINGTON, JR., Fall Curator of Coleoptera in the Museum of Comparatiave Zoölogy, now serving with an anti-malarial unit in the Pacific, is reported by the Associated Press as having had a distinctly unpleasant encounter with a crocodile in New Britain. Darlington, however, states that the alleged interview was fictitious as he saw no reporter: the following is a more accurate account of what occurred.

Dr. Darlington had worked his way out along a submerged log to the middle of a clean swamp studded with aquatic plants, and was dipping a test-tube in the clear water when he saw the crocodile rise. He started to return but, slipping on the log, plunged into the water. As he came to the surface the ten-foot crocodile seized his right arm, then employed the customary technique of rolling over and over as it backed away. Darlington, though more than 6 feet tall and weighing over 170 pounds, was tossed over and over as he was carried to the bottom.

Though Darlington struggled and kicked it was like trying to kick in a sea of molasses. His legs seemed heavy as lead and it was hard to force his muscles to respond. Seconds seemed like hours before the crocodile gaped and released him, possibly on account of his having landed a blow on its soft underside. Gasping, the captain struggled to the surface and swam to the edge of the pool. Hastily he tried to clamber up the bank, but slipped in the mud and rolled back into the ooze. On a second attempt he was more successful. Then for the first time he realized the painfulness of his wounds.

His left hand had been punctured by several of the crocodile's teeth while, in addition to dislocation and compound fracture of the ulna, the muscles and ligaments of the right arm were torn. Despite the severity of these injuries, within three or four days Darlington was able to write and shave left-handed. Later information is that he has made a good recovery and returned to duty. This will be welcome news for his many friends who are thankful he escaped a horrible fate.—A LOVERIDGE.

Editorial Notes

THE Editors hope our readers will forgive delays in publication of COPEIA, due mainly to war shortages of material and labor and to the slow return of authors proofs. If you have a paper in press, please notify us promptly of any change in your address.

Aid in publishing the plates in the article by Robert B. Barden and L. James Kezer, in this issue, has been received from the DEPARTMENT OF ZOOLOGY, CORNELL UNIVERSITY.

COPEIA IS THE JOURNAL OF THE AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS

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